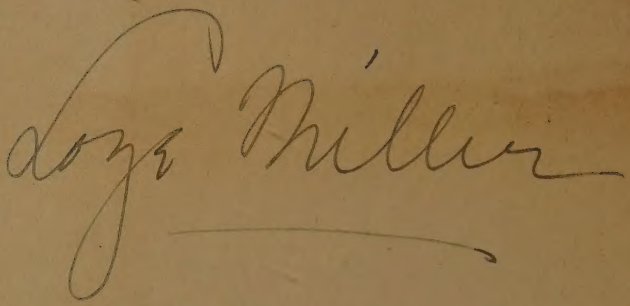
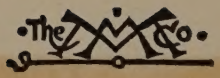


THE PRACTICAL VALUE OF BIRDS



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THE PRACTICAL VALUE OF BIRDS

BY

JUNIUS HENDERSON

PROFESSOR OF NATURAL HISTORY AND CURATOR OF MUSEUM,
UNIVERSITY OF COLORADO

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BIRD NEIGHBORS

You call them thieves and pillagers; but know
They are the wingèd wardens of your farms,
Who from the cornfields drive the insidious foe,
And from your harvests keep a hundred harms;
Even the blackest of them all, the crow,
Renders good service as your man at arms,
Crushing the beetle in his coat of mail,
And crying havoc on the slug and snail.

LONGFELLOW, *Birds of Killingworth.*

PREFACE

A vast amount of literature discussing the food habits of birds and their relation to the material welfare of the human race is so scattered as to be practically unavailable to the general student or busy teacher, who has neither the time nor library facilities for the investigation, yet desires a good fund of accurate knowledge of the more important facts. This volume is an effort to analyze and digest the North American literature of the subject and to bring together into one body the more significant data of Economic Ornithology in systematic arrangement, preceded by a discussion of the general principles involved and the more important groups of facts. This information has been condensed for busy men and women, but copious footnotes refer to numerous publications, making this volume a sort of digest-index of the literature, so that the reader may not only know upon whose authority any statement is made, but will also be advised of the books, magazine articles, bulletins or other publications where he may get more detailed information on each point.

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JUNIUS HENDERSON.

Boulder, Colorado,
January 15, 1927.

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PART I

GENERAL DISCUSSION

THE PRACTICAL VALUE OF BIRDS

I

THE ESTHETIC VALUE OF BIRDS

"The beautiful is as useful as the useful."
VICTOR HUGO.

Whatever tends to make the world better and happier; whatever ministers to the esthetic longings of the human soul; whatever leads the thoughts of men and women for the moment from the sordid pursuit of gain or from the race for personal aggrandizement to beauty in any form; whatever entices tired and care-worn people for a time from the shop, or office, or store, or mine, or quarry, and brings them into closer contact with the beauty, grace and charm of things out-of-doors; is of direct material value to the human race, even though that value may not be measurable in yards, acres, tons, bushels or dollars.

The partial outdoor life of the student of birds fits both mind and body for life's contests. Nothing so surely restores the soul, sickened with trouble, disappointment or defeat, as to get out into the fields and woods and watch our feathered friends, with their bright coats and graceful flight, to listen to their cheery songs and observe their interesting habits—their mating, their home-building, the rearing of their young, their comings and goings in the spring and autumn migrations.

In northern lands with what delight one glimpses the first Bluebird or hears the first note of the Robin or Meadowlark in the early spring! Then some fine morning early in May one finds the trees filled with a wave of bright-colored War-

blers of various species, stopping for a bit of breakfast on the way from the southland to their northern summer home. In the autumn one listens for the "honk" of the returning Geese, which have raised their broods in the north-land and are now on their long journey to their winter home. As the snow spreads over the fields one watches for the coming of the Horned Larks, Juncoes and Longspurs. Each month of the year has for the bird student something different from the preceding month's offering, and so, throughout the year, there is a constant feast of pleasure that rich and poor alike may enjoy.

Few civilized human beings doubt the value to humanity of music, poetry and the painter's and sculptor's arts. Even the savages of the Stone Age gave expression to a love of beautiful things in their rude drawings on cavern walls, and the wild tribes of the earth have their music, perhaps every bit as good as the crude beginning from which our own wonderful modern music slowly evolved. Beauty of every sort is good for the human soul, and he who fails to respond to its call loses much of the richness of life.

"If eyes were made for seeing,
Then Beauty is its own excuse for being."
—EMERSON.

Birds have been the inspiration of much that is fine in art, poetry and song. The world would be impoverished, indeed, if it were all destroyed. So, too, we should lose much if the chastening songs of birds were all hushed and their plumages turned to ashes.

"The Nature lover who listens to the Wood Thrush at dawn —an anthem of calm, serene spiritual joy sounding through the dim wood—hears it with feelings akin to those of the devotee whose being is thrilled by the grand and sacred music of the sanctuary. And he who, in the still forest at evening, harkens to the exquisite note of the Hermit—that voice of Nature, expressing in sweet cadences her pathos and ineffable mystery—experiences amid the falling shades of night emo-

tions which must humble, chasten and purify even the most upright and virtuous of men."—FORBUSH.

Imagine the joy in the observation of Nature in the open that could lead an ageing mine operator, with the soul of a poet and the eye of an artist, Denis Gale, to leave his business cares, sally forth with a pack on his back into the lonely fastnesses of the Rocky Mountains, and there, after studying the Hermit Thrush at its nesting site, to put such words as these into his notebooks, following the formal account of its habits: [1]

At an elevation of a little over 10,000 feet, in a sylvan, park-like shelter just where the conditions permit of a liberal growth of timber verging upon the vertical line of dwarfishness,[2] restricted perhaps to a few acres—ofttimes so many yards embrace these attractions in miniature; where the angular rocks, the decayed stumps with their prostrate trunks and the pigmy mounds and ridges of yet more aged monuments of decay all covered with mosses of liveliest green, mingled with dwarfed ferns, wild flowers and grasses of kindred tint, give to the whole groundwork a softness of effect and expression that is foiled by the angular trunks and limbs of the trees, at once restful to the eye and peaceful to the mind, altogether a scene of surpassing beauty—here dwells the Hermit. To note his glidings over this rich carpet of green, making his full stops and his half stops in length and duration, suggests his punctuating a sermon upon the harmony of the surroundings and loveliness. He acts no folly, thinks no evil, speaks no mischief. Wherefore should he be distrustful of harm to his home and brood? At present his mate performs her quiet function in a charming nest of moss and grasses secured by a few twigs in a small balsam hard by, which the genial warmth of July is forcing to infant maturity its young shoots, and the parent stem to a prodigality of perfume. Here sits our female Hermit in patient devotion, sheltered from the rough winds but open to enjoy to the fullest the cool, soft, sighing breath of summer. Here her cheek is crim-

[1] Quoted from Denis Gale's notebooks in Henderson, "An Early Colorado Naturalist—Denis Gale," *University of Colorado Studies*, V, 25-34, 1907.

[2] Evidently a reference to timber-line with its dwarfed trees.

soned by the matin ray, with languishing pleasure she marks its [the sun's] midday travel and receives the gilding of its vesper kiss. Within easy wing of her present charge are relics of previous summers which call up past thoughts of endearing labors. Within softening distance bubbles the mountain stream, the avenue by which the snows of yesterday upon the neighboring peaks in liquid haste reach here to temper meridian fervor. Everything is music, therefore her mate is silent. Birds of poetic tastes and habits, fast friends to solitude, fit ministers to share in sweet solitude's silent adoration!

More and more every year are the American people turning to the study of birds as part of their recreation. Ornithology has become a delight to thousands. Amateurs may be seen everywhere with field-glasses, cameras and notebooks in hand, peering into the bushes and treetops in the hope that some new candidate for observation may present himself; or that, perchance, by good fortune, he may be even induced to pose for his photograph, thus making a permanent visual record of the observation. "Hunting with a camera," instead of with a gun, has become a slogan in certain quarters. Other amateurs, leaving cameras, field-glasses and notebooks behind, perhaps derive more pleasure from their observations because they are not encumbered by accessories or the feeling that they must spend a portion of their time in using their paraphernalia and recording their observations with pen and ink.[3]

Printing presses are kept busy in the publication of books and magazines devoted wholly to ornithology, to say nothing of the numerous articles on birds in general periodical literature. Professional ornithologists are flooded with requests for information on the subject. Boys whose future once looked doubtful have become interested in birds and their protection, thus acquiring new ideas concerning the humane treatment of other creatures, and new interests in life to replace former bad habits; hence are destined to better citizenship.

There is no better training of the power of quick and accu-

[3] Grinnell, *Condor*, XXIII, 197, 1921.

rate observation, nothing more stimulating to the analytical qualities of the mind, than the study of birds in the field. No careless observer can correctly note the various characteristics by which species may be distinguished one from another as they flit through the bushes—the shape and size of the bill, wings and tail, the colors of various parts of the plumage, the song or call note, and so on. The botanist may sit down with book in hand and plant before him and study it at leisure. The geologist may put the fragment of rock in his pocket and examine it in the laboratory. The field student of ornithology must note and fix in his mind the details of structure and color of his bird on the instant, so that he will have an accurate picture of it in his mind as he seeks to identify it from descriptions and pictures in the books.

Hence from the moral, esthetic and educational points of view, as well as for purely utilitarian reasons, general public recognition of the value of birds is important. So in the detailed discussion of the strictly economic phases of bird life in the following pages we must not forget the less tangible values. We may well remember that even if the birds had no economic value whatever, they would still well deserve our study, encouragement and protection.

Do you ne'er think what wondrous beings these?
Do you ne'er think who made them, and who taught
The dialect they speak, where melodies
Alone are the interpreters of thought?
Whose household words are songs in many keys,
Sweeter than instrument of man e'er caught!
Whose habitations in the tree-tops even
Are half-way houses on the way to heaven!

—LONGFELLOW, *Birds of Killingworth.*

II

THE PRACTICAL VALUE OF BIRDS

Michelet long ago said:

"If it were not for birds no human being could live upon the earth, for the insects upon which birds live would destroy all vegetation."

Very much later a writer in *Forest and Stream* said:

"If the birds were all destroyed, agriculture in the United States would instantly cease."

Still later Forbush, one of our foremost writers on the subject, said:

"An acquaintance with useful birds of the farm is as important to the farmer as is a knowledge of the insect pests which attack his crops. . . . Were the natural enemies of forest insects annihilated, every tree in our woods would be threatened with destruction, and man would be powerless to prevent it."

These startling assertions are not the vain vaporings of dreamers and sentimentalists. They are the conclusions of trained scientists, based upon a great accumulation of information acquired only by the most painstaking and tedious investigation. Most of the very extensive literature upon this subject in America is written by investigators connected with the United States Department of Agriculture and various State Agricultural and Horticultural Departments and Societies, largely appearing as public documents, but a great deal of it, partly written by independent experts, scattered through scientific periodicals.

In some instances there has been a tendency to exaggerate the facts and to make assertions too extravagant concerning the value of birds. It may even be that if all birds were destroyed, other enemies of insects would be able to take care of the situation before desolation would become complete, but that no one can know. We do very definitely know that birds destroy a vast number of injurious insects, rodents and weed seeds every year, and are to be considered one of the most important factors in checking the increase of such pests, which, if unchecked by any means, would quickly prove very disastrous to the human race because of their wholesale and widespread destruction of vegetation. It is quite definitely known that ruthless slaughter of insectivorous birds has been followed locally by immediate increase in the numbers of insects, to the great injury of forest and agricultural crops; that wholesale destruction of birds of prey has been followed by "plagues" of mice and other mammal pests.

Through a very large amount of scientific research it is now known that the great majority of wild birds are highly beneficial to man, that many other species do much more good than harm, and that very few do more harm than good. This information forms the foundation of the laws for the protection of non-game birds which have been enacted in many states, not at the behest of sentimentalists, for esthetic reasons, but upon the urgent recommendation of the Department of Agriculture, for purely practical reasons. So thoroughly is the economic value of birds now established that even Italy, where destruction of small birds was greatest, has enacted laws for their protection.[1]

The number of species and subspecies of birds in the various states of the Union varies from about 235 to 530, the latter number being credited to California, where many local races are found. So varied are their habits that scarcely a pest of any kind can escape their attention. Swallows, Swifts, Martins and Nighthawks may be seen wheeling and zigzagging

[1] *Science*, n. s., XLIII, 65, 1916.

through the air, gathering insects on the wing. From high perches Flycatchers watch for flying insects and dart after them, catching them in the air. Towhees, under the bushes, find the lowly creatures which creep about on the ground and would thus escape the observation of aerial feeders. Chickadees, Tits, Nuthatches, Kinglets, Warblers and Wrens search the bark and leaves of trees and shrubbery for the insects and insect eggs they harbor. Some favor the lower branches, others prefer the topmost limbs, others indifferently search the trees from roots to top, scanning every nook and crevice for the small insects which would escape the attention of larger birds, but which are so destructive, including scale insects, plant lice and innumerable others. Hawks and Owls hover over fields, orchards, forests and meadows, watching for luckless mice, squirrels, rabbits and other destructive rodents, which girdle trees and destroy grain. Vultures ("Buzzards"), Gulls, and to a less extent Crows, Magpies and some other birds are scavengers, doing important service in ridding fields, shores and harbors of carrion. Finches and Sparrows haunt the weed patches during the winter, consuming almost incredible quantities of weed seeds, then in summer catch large numbers of insects for themselves and more particularly for their young. Woodpeckers destroy the larvæ of wood-boring insects, which cannot well be reached by other birds, though the Flicker and some other species of the family also descend to the ground and pick up myriads of ants. Many species that are not highly insectivorous as adults, feed their young almost entirely upon soft-bodied insects during the first few days of their existence, while they are growing rapidly and require prodigious quantities of food.

Though the usual food of most species consists of either fruits, seeds, grains, insects, small mammals or green vegetation, there is scarcely any possible kind of food that is not at some time taken by some kind of bird.

Amphipod crustaceans have been found in the stomachs of 30 species of North American birds, including, as would be

expected, 6 species of Shorebirds and 14 of Ducks.[2] Crayfishes and other crustaceans are found in the stomachs of many other species. Mollusks are taken by many birds and form a large part of the food of some species, as in case of the "Snail Hawk," or Everglade Kite, which is said to feed chiefly upon aquatic snails of the genus *Ampullaria*.[3] The stomach of one Scaup Duck contained 74 snails, and 6 Canvasback Ducks shot in British Columbia were filled with fresh-water snails, containing no other food.[4] Strangely enough, large flocks of Waxwings were found feeding upon small aquatic snails at the edge of water-cress swamps in Colorado.[5] Many insects generally supposed to be immune from attack because of protective coloration, protective or mimicking form, nauseous odors and defensive armatures, are eaten by many birds, and in case of some species of birds they form a considerable percentage of the average annual food.[6] Not only do Kingfishers, Ospreys and many aquatic birds eat fish, but even Robins, Blackbirds and Magpies have been observed feeding upon live trout fry.[7]

Some species, including House Finches, Cassin Purple Finches, Pine Siskins and Crossbills, have been detected eating even salt, in one instance, at least, mixed with sulphur.[8] Ostriches are said to be "very fond of salt, a certain amount of which seems to be essential to them."[9] In experiments with Canaries, on the other hand, it was found that they would not take even a 5 per cent solution of salt.[10] The Kittiwake is said to drink salt water and refuse fresh water, while the Western Gull drinks salt water but does not like

[2] McAtee, *Auk*, XXX, 136-137, 1913. Jackson, *Bull. Wisconsin Nat. Hist. Soc.*, X, 49-60, 1912.
[3] Lang, *The Nautilus*, XXXVII, 73-77, 1924.
[4] Judd, *U. S. Biol. Surv., Bull.* 17, 81, 1902. Hanham, *The Nautilus*, XXVIII, 88, 1914.
[5] Lincoln, *Auk*, XXXVII, 73, 1920.
[6] Beal, *Year Book U. S. Dept. Agric. for 1908*, 346.
[7] Bergtold, *Auk*, XLIII, 558, 1926.
[8] Reeks, *Bird-Lore*, XXII, 286, 1920. Kelso, *Bird-Lore*, XXIII, 197, 1921. Kelly, *Condor*, XXIII, 165, 1921. Pierce, *Bird-Lore*, XXIII, 90-91, 1921.
[9] Knowlton, *Birds of the World*, 64, 1925.
[10] Science News Supplement, *Science*, June 5, 1925, xiv.

food that is very salty.[11] The Passenger Pigeons, now extinct, are said to have been very fond of salt or salt mud from the saline springs, and were thus easily trapped in large numbers about the "salt beds." [12]

The Ruddy Quail-dove in Porto Rico feeds partly upon the fruit of Manchineel,[13] which is very poisonous to human beings, and many American species of birds are known to feed extensively upon the seeds of poison ivy.

Some species are with us the year round, others remain only during the summer, while others come in from the North to spend the winter months. Thus the good work goes on winter and summer, from the peep of dawn to the late hours of twilight, the owls even working on night shift. The birds, with their extremely variable but in a very large measure useful food habits, fill a large place in the Economy of Nature. It is strange that men were so long in coming to recognize the value of the feathered tribe, and even at the present time there is appalling and widespread ignorance of the real facts, even among otherwise well-informed people.

Perhaps it was the fact that in some European and other countries insectivorous song birds are still considered a source of human food, or possibly the fact that not a great while ago such useful birds as the Flicker were sold in the open markets of the United States, that inspired this bit of verse:

I saw with open eyes
Singing birds sweet
Sold in the shops
For people to eat,
Sold in the shops of
Stupidity Street.

I saw in a vision
The worm in the wheat,
And in the shops nothing
For people to eat;
Nothing for sale in
Stupidity Street.

—Ralf Hodgson.

[11] Bent, *U. S. Natl. Museum, Bull.* 113, 39-40, 95-98, 1921.
[12] Barrows, *Birds of Michigan*, 242, 1912.
[13] Wetmore, *U. S. Dept. Agric., Bull.* 326, 49, 1916.

III

CROPS AND FORESTS SAVED BY BIRDS

Birds that ordinarily take small numbers of insects as food, take them in much larger quantities when the insects become more abundant. The same is true of birds that eat mice, gophers, prairie-dogs and other destructive mammals. The facility with which birds, within certain limits, may turn from one kind of food to another and the ease with which they pass from one locality to another, make them especially valuable as enemies of agricultural pests, and enable them often to save crops, orchards, and forests from destruction.

It is well known to naturalists that when insects, rodents, or other food for birds become unusually plentiful in a particular locality, birds flock to the vicinity from quite a distance.[1] There are numerous apparently well-authenticated instances of such gatherings mentioned in the literature. How the birds discover these unusual local conditions is not always clear. There is reason for the belief that in some instances the mortality of young birds is reduced because of the abundance of food, resulting in a real increase in the total numbers of birds, not a mere assembling of scattered birds from the surrounding region, but that is quite certainly not always the case.

An interesting and instructive instance is furnished by Eastern Massachusetts, where a great increase in the rabbit population during a favorable season was followed the next

[1] McAtee, "Local Suppression of Agricultural Pests by Birds," Ann. Rept. Smithsonian Inst. for 1920, 411, 438; *Auk*, XXX, 135, 1913. Bryant, "Birds in Relation to a Grasshopper Outbreak in California," *Univ. Calif. Pub. Zool.*, XI, 17, 1912.

winter by an unusual number of Great Horned Owls, which fed extensively upon the rabbits.[2]

Possibly the best-known incident of the sort is that of the Gulls and crickets in the early history of Utah, which has been related in many publications. Myriads of crickets, having destroyed one crop in the Salt Lake Valley, were fast ruining the second, which would have left the people, in the absence of transportation facilities or ready communication with the outside world, in dire distress. Before it was too late Gulls arrived "by hundreds and thousands," and saved the crops from destruction and the settlers from starvation.[3] In commemoration of this event, which was considered by the Mormons a miraculous intervention of Providence, the people have erected a beautiful and expensive monument to the Gulls.[4]

One of the most notable outbreaks of insects in the history of the United States is the Rocky Mountain migratory locust plague of 1873 to 1876 in the Great Plains region, which was thoroughly investigated at the time by government agents, who collected a large amount of definite data as to the important part birds played in the control of the insects. Owing to the widespread extent of the visitation, obviously there were not enough birds to control it over the whole area, but locally many fields of wheat and other crops were saved from the ravages of the insects by various species of birds. Indeed, it is said that the only fields in that great region that were not ruined were those to which birds flocked.[5]

Another spectacular and destructive movement of insects was the migration of the Colorado potato beetle across the United States many years ago. Many fields of potatoes were

[2] Beal, "How Birds Affect the Orchard," *Year Book U. S. Dept. Agric. for* 1900, 300.

[3] For details see, among other publications, Cannon, *Irrigation Age*, VII, 188-189, 1894. McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 415. McAtee and Beal, U. S. Dept. Agric., *Farmers' Bull.* 497, 21-22, 1912.

[4] A fine photograph of this monument appears as a frontispiece in Forbush, *Bull.* 9, Mass. Dept. Agric., 1921.

[5] Aughey, 1st Rept. *U. S. Entom. Comm.* (for 1877), 1878. McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 411, 415.

destroyed and great damage done to others before methods of artificial control were developed, but there are numerous accounts of the local rescue of crops from the beetles by flocks of birds.[6] The much-detested English Sparrow is said to have saved a crop of asparagus from the asparagus beetles at Buffalo, New York.[7] California orchards have several times been saved from outbreaks of canker worms by Brewer's Blackbirds, which flocked to the rescue and worked from tree to tree, completely cleaning the insects out.[8] The same well-known bird of the West saved the foliage in Northern California from a plague of caterpillars.[9] They also visited the fields in large numbers during a bad outbreak of butterflies and materially helped in getting the insects under control, 95% of their food at the time consisting of the butterflies.[10] Allen reports that in one section of Nebraska the Blackbirds, Quail and Plover gathered in numbers and saved fields of wheat from a grasshopper invasion.[11]

Several years ago in Colorado the "beet worms" were working havoc in the sugar beet fields and the farmers were preparing to fight the enemy when they noticed great flocks of Red-winged Blackbirds hovering over the fields devouring the insects. Next day the fields were almost entirely free from the larvæ, and the birds, having finished the job, had departed.

Nearly 20 years ago, at Boulder, Colorado, for several years the leaf-rollers defoliated the box-elder trees, and it seemed that they were doomed, but in the third year of the attack Red-winged Blackbirds appeared on the scene and soon freed the trees of the insects, which have made no serious trouble there since. Inasmuch as these birds had not been in the habit of visiting the city, it is difficult to explain how they dis-

[6] Beal, *Farmers' Bull.* 54, 29, 1904. McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 419.
[7] Adams, *Bull. N. Y. State Museum*, VII, 1007, 1901.
[8] Beal, *Yearbook U. S. Dept. Agric. for* 1908, 345; *U. S. Biol. Surv., Bull.* 34, 60.
[9] Bryant, *Condor*, XIII, 195-208, 1911.
[10] Bryant, *Investigation of the Status of Non-game Birds*, 8, 1912.
[11] Allen, *Cornell Reading-Courses*, IV, No. 76, 21, 1914.

covered the abundant supply of insects, but similar occurrences are so common among birds that there is nothing surprising about it.

Forbush, in various publications,[12] has published many instances of the rescue of crops, orchards, forests and shade trees from insect outbreaks or invasions, of which the following are good examples: White grubs nearly ruined the vines in a cranberry bog at Wareham, Massachusetts, but the Robins discovered in the grubs a convenient and abundant source of food for themselves and made short work of cleaning out the bog and saving the cranberries. In the same vicinity a cankerworm outbreak in an orchard was checked by a large flock of Cedar Waxwings, which also cleared the elm trees of their greatest foe, the elm-leaf beetle, at Lee, in 1911. Woodpeckers saved the elms from insects at Cleveland, Ohio, in 1881. In the state of Washington in 1919, during a cricket outbreak, Meadowlarks assembled in great numbers and completely cleared the fields of the insects. Warblers and Goldfinches ridded an orchard of the very destructive imported pear-tree psylla. At Concord, Connecticut, Myrtle and Blackpoll Warblers cleared the poplars of an immense swarm of plant lice in a single day. At Wareham in 1901 Chipping Sparrows brought under control a plague of pea lice. Bobwhites and Rose-breasted Grosbeaks have been known to save potato fields from the Colorado potato beetle. Titmice and Kinglets saved the trees of Count Wodzicki from insects in 1848 to 1850. Crows gathered in flocks of thousands to repell an invasion of grasshoppers in Australia in 1894, and for a month fed entirely upon the insects, consuming many millions, the contents of the stomachs averaging 100 grasshoppers each. There was a similar gathering of crows during the locust outbreak in New South Wales in 1891. In 1892 a

[12] Forbush, "Useful Birds and their Protection," Mass. Board of Agric., 1907; 4th *Ann. Rept. Mass. State Ornithologist* (in 59th Ann. Rept. Mass. Board of Agric., 1912); "The Utility of Birds," Mass. Dept. Agric., *Bull.* 9, 1921; 8th *Ann. Rept. Mass. State Ornith.* (for 1915).

locust outbreak in Victoria was brought under such complete control by the Starlings, Spoonbills and Cranes that gathered to feed upon the insects, that the damage to crops was very slight.

McAtee,[13] in a very interesting and important paper on this subject, relates more than 70 instances of the local extermination of plagues of insects and other pests by birds, or their reduction to such small number that no further damage was done. These probably constitute only a very small proportion of all such instances—only those which have happened to come to the attention of one naturalist. Doubtless in thousands of cases the "clean-up" is made before the damage has been sufficient to attract attention. In many other cases the insects disappear without the cause of their disappearance being detected, in the absence of naturalists trained to investigate such phenomena. The following are among the cases reported by him: One spring, rose beetles appeared in large numbers at Clovis, California, and, after destroying the roses, took to the vineyards and began doing considerable damage to grapes, but were checked in their depredations by a great flock of Brewer's Blackbirds. In Dry Creek Valley, California, several times Brewer's Blackbirds have rescued prune orchards from serious attacks of cankerworms and a similar invasion that defoliated all trees except poplars in Manhattan, Kansas, was checked by English Sparrows, Vireos and other birds.

Near Rochester, New York, the pear-tree psylla destroyed one pear crop and left innumerable eggs as a menace to the next year's crop, but during the winter Red-breasted and White-breasted Nuthatches in flocks worked the orchard in search of the eggs, so that in the spring but few insects were left and the owner estimated that he had been saved thousands of dollars by the birds.[14]

[13] McAtee, "The Local Suppression of Agricultural Pests by Birds," *Ann. Rept. Smithsonian Inst. for* 1920, 411-438. For other instances see McAtee, *Auk*, XLI, 629-632, 1924.

[14] Surface, Pennsyl. Dept. Agric., *Zool. Quart. Bull.*, I, No. 3, 1, 1903. Forbush, Mass. Dept. Agric., *Bull.* 9, 26, 1921. McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 418.

The Coulee cricket devastated large areas in the vicinity of Adrian, Washington. In 1918, while the state, with the aid of the United States Department of Agriculture, was attempting to control the insects, Meadowlarks appeared in flocks and began to eat the newly-hatched crickets.

"So efficient were they in controlling the situation that arrangements for a 1919 campaign were abandoned. The Meadowlarks were almost entirely responsible for the complete clean-up of the area." [15]

Hewitt says that in 1905 the Heinrich Wood, south of Eisenach, Germany, was completely defoliated by caterpillars. The wood of Baron von Berlepsch, near by, in which bird-life had been encouraged by numerous nesting-boxes, was untouched by the insects, but stood out amid the desolation like a green oasis in a desert.[16]

Tent caterpillar plagues have been cleaned up by Baltimore Orioles in Connecticut, Cedar Waxwings in Ohio and Cuckoos and other birds elsewhere.[17] In 1880-1881 Woodpeckers checked a serious attack of tussock moths upon the elm trees at Cleveland, Ohio.[18] In 1895 an overabundance of locust-leaf mining beetles threatened the locust trees at Marshall Hall, Maryland, but birds of many species rallied and effectively repelled the attack.[19]

In a large number of cases birds have suppressed local plagues of lepidopterous insects, one of the most injurious of which is the orchard tent caterpillar, which was entirely cleared out of an orchard near Cleveland by Blue Jays.[20]

On a Maryland farm various species of the Finch family

[15] Burrill, *California Fish and Game*, VI, 38, 1920. McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 415-416.
[16] Hewitt, *Ottawa Naturalist*, XXVII, 166, 1914.
[17] *Cultivator and Country Gentleman*, XLIV, 407, 1879. McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 266, 1907. Sherman, *Bull. N. Y. State Museum*, VII, 1019, 1901. Butler, *Rept. Dept. Geo. and Nat. Res. Indiana for* 1897, 824. Forbush, *Useful Birds*, 266, 1907.
[18] Sterling, *Insect Life*, III, 295, 1891.
[19] Judd, *U. S. Biol. Surv., Bull.* 15, 35, 1901.
[20] Kirtland, *Atlantic Monthly*, XXV, 483-484, 1870. McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 421.

swarmed where smartweed formed a tangle on low ground, and fed upon the seeds, with the result that no smartweed was found there during the ensuing year.[21]

Owls have figured as efficient aids in the abatement of various plagues of voles in England and Continental Europe. Of one such instance it was quaintly said in Holinshed's Chronicle: [22]

"Which vermin by policie of man could not be destroyed, till at last there gathered together such a number of Owles as all the shire was not able to yield, whereby the marsh holders were shortly delivered from the vexation of the said mice."

It is thus seen that birds are able to and often do control local outbreaks of insects, but obviously there are not enough birds to effectually check widespread outbreaks, so that man must be eternally vigilant and industrious in the application of artificial methods of resisting such attacks. The most important work of birds in connection with the suppression of agricultural pests is in keeping them in check at all times and thus as a general thing preventing the greater plagues, which subject is discussed in a subsequent chapter.

[21] Judd, *U. S. Biol. Surv., Bull.* 15, 27-28, 1901.
[22] See Lantz, *U. S. Biol. Surv., Bull.* 31, 47-48, 1907.

IV

SENSE AND SENTIMENT

The food habits and interrelations of birds and other organisms are highly complex. Conclusions concerning the economic status of any species should be based, not upon sentiment or casual observations, but upon accurate and adequate evidence and sound reasoning. Possession of a few facts may easily lead to action that would be severely condemned were all the facts known and viewed in their relations to one another. Indeed, just such mistakes have been made, and not infrequently, especially in the early history of ornithology. Much harm may come from failure to know, understand and fairly face facts. We should be governed in all cases by sense, not merely by sentiment. Sentiment is a very fine thing in its proper place, coupled with good sense. Indeed, it is quite necessary to the welfare and happiness of the human race, but it is not a good substitute for sound judgment.

Pearson, of the National Association of Audubon Societies, whose avowed purpose is the protection of birds, recognizing the danger of unsound views on the subject, has recently [1] published a strong plea for the avoidance of extreme ideas on the subject of bird conservation. Advocating strict protection of all birds, regardless of circumstances, will not win for the general cause of conservation the enthusiastic support of farmers and fruit growers who see their products menaced by the undue increase of certain species of more or less gregarious birds. On the other hand, he who seeks the destruction of any

[1] Pearson, "Conservative Conservation," *Bird-Lore*, XXV, 452-453, 1924.

species without regard to the evidence as to its true relations to human welfare cannot command the support of the well-informed section of the general public.

Certain species of birds, usually useful, may become quite harmful when driven to cultivated crops by inordinate increase in numbers or the failure of their accustomed supply of food. The latter is said to have been the cause of the raid upon the olive groves by Robins in California in 1900-1901.[2] Blackbirds, Crows and Ring-necked Pheasants may do much damage when they congregate about the fields in too great numbers, though normally they do considerable good. Bobolinks have inflicted great injury to rice fields in the South, though in the North they are not considered harmful under ordinary circumstances.[3]

It is well known that Robins and some other birds that do a great deal of good during most of the year are capable of much harm about the orchards during the cherry season. In an Oregon Valley Sage Thrashers developed the fruit-eating habit to such an extent that they inflicted 25 per cent damage to the grape crop.[4]

Species of birds which, in one locality or under certain conditions, are quite useful, may in another locality or under other conditions become either neutral or actually harmful.[5] Within reasonable limits the food they take at a given time or place depends upon what is available in sufficient quantity and easily accessible.[6] This is an important factor in the usefulness of birds. It enables them to live through periods of shortage in their natural food and to be ready in time of great abundance of agricultural pests to turn their attention to such pests and aid in their control.

When craneflies are abundant birds may feed freely upon

[2] Beal, "The Relation of Birds to Fruit Growing in California," *Yearbook U. S. Dept. Agric. for* 1904, 242, 252-253; *U. S. Biol. Surv., Bull.* 30, 9, 1907.
[3] Stone, *Auk*, XXXVII, 167, 1920.
[4] Kennedy, *Auk*, XXVIII, 225-228, 1911.
[5] Judd, *U. S. Biol. Surv., Bull.* 17, 9, 1902. Stone, *Auk*, XXXVII, 167, 1920.
[6] Beal. U. S. Dept. Agric., *Farmers' Bull.* 630, 1, 1915.

them, and then turn to Mayflies when the latter are abundant.[7] The Starling appeared to be a quite useful bird in England before it became over-abundant, but by 1919 it had become a "serious menace to the production of home-grown food."[8] Will it become in time as serious a nuisance in America, now that it has gotten a start and is spreading so rapidly?

It is not uncommon for a few individuals belonging to a usually useful species to develop bad habits, especially when their natural food is scarce. That may afford a perfectly good reason for summarily disposing of the vicious individuals, but not for wholesale slaughter of the species. When some human beings indulge in criminal acts we do not imprison or hang the whole human race. A few Brewer's Blackbirds formed the habit of killing young Pheasants. By shooting the few who were indulging in that practice the trouble was all stopped and the rest of the birds were allowed to continue their good work.[9] Thus good judgment, without prejudice, won the battle, where an extreme position on either side of the problem might have been disastrous.

Some birds of families which, in the United States, are considered more or less strictly insectivorous, including Vireos, Flycatchers, Warblers and Woodpeckers, in the West Indies feed largely upon fruit and seeds, though insects are very abundant there.[10]

When any species of birds appears in such numbers, or under such circumstances, or changes its habits in such a way, as to do great harm, it is entirely justifiable to adopt any necessary measures to reduce its numbers, just as we do with destructive insects and rodents, though wholesale slaughter should be indulged in only after careful and thorough investigation and in extreme cases.

[7] Judd, *U. S. Biol. Surv., Bull.* 17, 21-25, 1902.

[8] Kalmbach, *Auk*, XXXIX, 189-195, 1922, citing Collinge, *The Food of Some British Wild Birds*, London, 49, 1913; "The Plague of Starlings," *National Review*, No. 434, 252-257, 1919; "The Starling: Is It Injurious to Agriculture?" *Journ. Ministry of Agric.*, XXVII, 1114-1121, 1921.

[9] Finley, *Condor*, XXV, 179-180, 1923.

[10] Bowdish, *Auk*, XX, 193-195, 1903. Wells, *Auk*, XIX, 348, 1902.

On the other hand, it would be well to remember always that if a Robin picks a few cherries during the fruit season, he is only collecting his pay for considerable good he has done during the other months of the year. If a Blackbird gets a little corn, he may have earned it by the destruction of insects which would otherwise have done more injury to the crop than the birds do. If we fail to pay the birds their fair wages for the police work in which they are engaged throughout the year, we may be heavy losers in the end. If we are to accept their services in our behalf, good sense and good sportsmanship demands that we be not too severe upon them when they indulge in a little mischief. Many species of birds that are sometimes locally more or less harmful, during most of the time are more or less useful, and by their occurrence in large numbers when insects or other farm, orchard or forests pests are overabundant, often save crops and trees from ruin.

We must also remember that after the birds have done their very best for us, we must still do considerable for ourselves. McAtee, one of our leading economic ornithologists, has this to say: [11]

"When we consider the degree of insect control necessary to the commercial success of crops, it is evident that man must almost invariably depend upon his own efforts. We must know about natural enemies, give them all due credit and protect them, but we must beware of exaggerating their services. People are too easily misled in this direction, but the final result of too great faith in natural enemies is disappointment."

One trouble is that man has introduced entirely new elements into Nature, on a vast scale, and Nature, in its naturally slow method of development, has not yet caught up with changing conditions. Under natural conditions there were no vast fields of corn, wheat, beans, cabbages, potatoes and other products of the modern farm, no great orchards and vine-

[11] McAtee, *Auk*, XXX, 136, 1913; *Yearbook U. S. Dept. Agric. for* 1911, 345.

yards, to afford hiding places, breeding places and abundant food for myriads of insects and multitudes of rodents. If there were enough strictly insectivorous birds to suppress all insects during the season when insects are available, they would starve to death during the other months of the year (unless they could turn to other kinds of food), and then there would be no insectivorous birds to fight insects during the following seasons. Perhaps in the course of time Nature may be able to effect a complete readjustment, but if so, it will doubtless be in the quite distant future. Meantime our present need calls for the largest possible degree of wisdom and discretion, coupled with accurate and adequate information and complete freedom from prejudice either for or against the birds, in order that, as each problem arises, we may meet it fairly and reach conclusions that will not result in disaster.

"Natural enemies of birds are necessary and desirable, as they tend to maintain within proper bounds the number of species on which they prey; organized attempts to increase the number of birds over large areas by destroying indiscriminately all natural enemies are undesirable; under certain circumstances enemies which have been able to adapt themselves to man and his works and have become unduly numerous may require reduction in numbers; individuals of useful species which may become particularly destructive should be eliminated." [12]

Those who object to the taking of the lives of any birds, or for that matter of any other form of animal life, as well as those who seem to favor indiscriminate slaughter, should carefully ponder a most excellent editorial in a recent number of Bird-Lore, from which the following sensible remarks are extracted:

"The so-called Nature-lover who takes his own standards, personal likes and dislikes afield with him, is apt to find quite as much to condemn in animal, as in human life. Nature

[12] Forbush, "The Natural Enemies of Birds," *Mass. Board of Agric., Bull.* 3, 1916; *Bird-Lore*, XVIII, 376, 1916.

attracts us because she is natural. It is the wild, not the tame animal which appeals to us; and we want it to exhibit the traits which have won for it a place among its competitors. The Phoebe snapping up an insect is no less a murderer than the Sharp-shinned Hawk that captures a Bluebird. That the Bluebird arouses a sympathy the no less unfortunate insect fails to awaken is our misfortune rather than the Sharp-shin's fault. The Shrike which sights a grasshopper at a distance of 100 feet or more and, after capture, impales it on the barb of a wire fence, deserves approval for skill and adaptability rather than condemnation for cruelty.

"The laws of Nature demand the sacrifice of life that it itself may live. If we attempt to control the numbers of those animals which prey upon other animals we should ourselves become the greatest of destroyers. If we favor one form of life it is probable that we shall do so at the expense of other forms of life. It behooves us, therefore, to use our power with extreme caution, always remembering that it is far greater for evil than it is for good. We can destroy where we cannot create." [13]

[13] *Bird-Lore*, XXVII, 203, 1925.

V

THE BALANCE OF NATURE

As naturalists have come to study species more in their relation to and association with one another, they have recognized in Nature a complex system of checks and balances, each species acting as a check upon others, and thus preserving what has become known as the "Balance of Nature."

Buckland writes: [1]

"The whole system of Nature is in exquisite poise, and it is not possible to lay rough hands upon it without disturbing it in directions and on a scale which at the time may not be guessed at. If we remove or reduce the working power of one living organism which acts as a check on another, the latter, freed from restraint, will inevitably multiply."

This idea was well set forth many years ago [2] by Kirby and Spence, and there is available a very illuminating discussion of the interactions of organisms, by Forbes.[3] This balance or adjustment must not be considered a fixed, immutable schedule. It is the outcome of ages of evolution, and has always been subject to constant readjustment—never more so than now, with the great disturbance due to advancing civilization, which is rapidly changing physical conditions everywhere, and the extension of agriculture into vast new districts.

In the rapid settlement of a country it is impossible to avoid a disturbance of the equilibrium, delicate and unstable

[1] Buckland, *Ann. Rept. Smithsonian Inst. for* 1913, 441.
[2] Kirby and Spence, *An Introduction to Entomology*, 7th Ed., Letter IX, 145, etc., 1857.
[3] Forbes, *Bull. Illinois State Lab. Nat. Hist.*, I, No. 3, 6-16, 2nd Ed., 1903 (1st Ed. 1880).

at the best, by destroying breeding places and food supplies of certain species in bringing land under cultivation, at the same time providing better breeding places and more abundant food for other species.[4] This, however, does not excuse unnecessary disturbance of natural conditions by deliberately destroying useful species or permitting them to be destroyed. It makes it even more imperative that all species not actually known to be harmful be given an opportunity to show what they can do in the way of restoring and preserving the equilibrium. Much is found in the past history of agriculture in America and elsewhere to indicate that trouble with various pests is likely to immediately follow the extension of agriculture into new regions, but that in time some degree of readjustment takes place. Thus Beal noted in 1904 that Blackbirds were becoming less destructive to grain, indicating that adjustment was in progress.[5] Even under changed conditions due to the intervention of man the tendency is "directly toward the establishment of a balance."[6] It should be our aim to aid, rather than to hinder, Nature in the accomplishment of the readjustment.

From almost the very beginning of life upon this planet, species have been engaged in a more or less constant struggle for existence, competition at times becoming acute. In the effort to perpetuate itself each species is more prolific than would be necessary were there no enemies, otherwise the species would long ago have been exterminated. Hence any species in time would populate the whole earth were it not kept in check by its enemies, organic and inorganic (including storms, etc.); and, having covered the earth, would become so abundant that there would not be food enough to supply the demand, starvation would check its increase and perhaps ultimately annihilate it.

The Balance of Nature idea, although sound in principle

[4] Beal, *Yearbook U. S. Dept. Agric. for* 1904, 241-245; *Yearbook for* 1908, 348.
[5] Beal, *Yearbook*, 1904, 245; *U. S. Biol. Surv., Bull.* 30, 12.
[6] McAtee, *U. S. Biol. Surv., Bull.* 32, 89, 1908.

and supported by abundant evidence, may easily be carried altogether too far. It has been argued that even house flies and other pests were put into the world for a divine purpose and should not be interfered with. A little knowledge of natural history would dispel such an illusion. The argument seems to have been convincingly answered some years ago.[7] Furthermore, it failed to take into account the increased breeding places, the increased and more concentrated human population, and other disturbing factors in Nature's economy.

Probably under normal natural conditions no species is altogether harmful and few, if any, altogether useful.[8] Many species normally useful or at least harmless, may become quite harmful if not kept in check by natural enemies. Therefore it is quite possible for us to give too complete protection to a very useful species thus disturbing the equilibrium and making the bird one of doubtful value, if not actually harmful, at least temporarily. It has been declared that in some localities too many nesting boxes for Wrens have caused such an increase in the numbers of this delightful but pugnacious species as to make it a menace to other birds, which it drives from their nesting sites.[9] This conclusion is not yet fully accepted, but at any rate the bird is now under suspicion. It must be remembered that diversity of insectivorous birds is as important as numbers, each species preying upon some kinds of insects not obtained by other birds. Consequently any bird that to any notable extent drives out other species of birds may be viewed as a suspicious character. There is, however, much to be said in favor of the Wren.

Fruit trees usually put forth more fruit buds than can mature into choice fruit and often more foliage than is really advantageous. Insects in reasonable numbers to carry on the work of budding the trees early in the season may in some

[7] "The Unbalancing of Nature," *Nature and Culture*, V, 32-34, 1913.
[8] Henshaw, "Does It Pay the Farmer to Protect the Birds?" *Yearbook U. S. Dept. Agric. for* 1907, 156.
[9] Sherman, *Bird-Lore*, XXVII, 97-100, 124, 125, 1925. See further discussion in the systematic part of this book.

cases be useful, but if they greatly increase in numbers they would become harmful. When they become too numerous they have been known to attract many species of birds that are looking for a plentiful food supply, this acting as a check upon the insects. The setting out of large orchards affords an immediate opportunity for the increase of insect pests, while the birds that feed upon insects increase very much more slowly. Thus the natural adjustment of species is disturbed and it requires a long time to restore the equilibrium, if it is ever restored.

Darwin considered the interrelations of organisms in his Origin of Species. Among many other examples he says that the bumblebee is one of the few, if not the only, insect capable of visiting and pollenizing the red clover; that the number of bees in any region depends largely upon the number of field mice, as the latter destroy the combs and nests of the bees; that the number of mice depends largely upon the number of cats (he might much better have said Hawks and Owls), because cats destroy mice.

"Hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention first of mice and then of bees, the frequency of certain flowers in that district."

Fisher [10] tells of a marsh in New York inhabited by Ducks, snapping turtles and other animals. The turtles laid their eggs in the sand and skunks ate many of the eggs, thus preventing the overabundance of turtles. When skunk fur became valuable, these animals were killed for their fur. Then the turtles so multiplied that their ordinary food was not sufficient, and they began to prey upon the young Ducks. Thereupon the Ducks deserted the marsh as a nesting place. Finally skunk fur became less valuable and the boys began to catch turtles for the market, thus restoring the equilibrium, and the Ducks in time returned to the marsh.

An alarming scarcity of lobsters on the Breton coast was

[10] Fisher, *Yearbook U. S. Dept. Agric. for* 1908, 191-192.

recently attributed to the scarcity of eels, which usually keep in check the octopus, an active enemy of the lobster.[11] In the South, Herons eat many crayfish. The crayfish is said to feed upon young fish spawn. The young fishes eat mosquito larvæ.[12] As the mosquito is the host of the malaria germ, it is quite conceivable that the destruction of Herons might have a disastrous effect upon the health of the human inhabitants, unless other means were adopted to control the breeding of mosquitoes. Alligators are in the habit of feeding to some extent upon rabbits and other injurious rodents, and upon muskrats, which cause much damage to the levees and rice fields in the South. It is said that the destruction of alligators for their skins, to be used in the manufacture of leather, led to a marked increase in those mammal pests.[13] Prairie-dogs, gophers, rabbits and other rodents in the Western States increased as some of their enemies, such as Hawks, Owls and coyotes diminished in numbers under the attacks of the settlers, and now large sums of money are expended annually in the effort to keep the rodent pests under control.

A species that is harmless, or even useful, in its native haunts, may become injurious when transported to a new environment, where some of the natural checks upon its increase are lacking, or where lack of its natural food or the presence of another kind of food that is more desirable may cause a marked change in its food habits. The introduction of a species into any region may disturb the balance just as profoundly as the extermination of one native to the region. Such importation is now, as a result of disastrous experience, prohibited in some countries, except under strict supervision, as is the case in the United States.

It is said that the Skylark, Green Linnet and Black Thrush are considered beneficial in Europe, where they are native, but upon importation into New Zealand they "developed traits which render them far from desirable additions to the

[11] Smith, *Nat. Geog. Mag.*, XX, 553, 1909.
[12] Baynard, *Wilson Bull.*, XXIV, 167-169, 1912.
[13] *Young People*, Philadelphia, XXXVI, 72, 1916.

fauna of that island,"[14] and naturalists have watched with interest the result of the introduction of the Little Gray Owl into New Zealand for the purpose of fighting the English Sparrow.[15] European rats, accidentally introduced into various countries, have become a great nuisance. In Jamaica the Indian mongoose was introduced to fight the rat plague. It turned its attention to game birds, poultry, young pigs and lambs and became a great pest, feeding also upon many song birds, snakes and lizards, which are enemies of insects. Then followed an increase of insect pests. Disaster also followed the importation of the mongoose into the Hawaiian Islands, and its importation into the United States was barely prevented. It played havoc with some of the ground-nesting birds when imported into Porto Rico.[16] Rabbits were introduced into Australia for purposes of sport. In the absence of predatory animals they spread over the whole country like a scourge, and immense sums have since been spent in the effort to check their depredations. In New Zealand, ferrets, stoats and weasels were imported to destroy the introduced rabbits, and as a result some of the native birds were soon threatened with extermination. This whole subject has been well discussed by Palmer.[17]

The introduction of the English Sparrow into the United States, the consequent decrease in the number of insectivorous birds in some localities and the increase of certain insect pests, are too well known to need much discussion.[18] Forbush says that this bird was introduced into America to fight the caterpillars of the snow-white Eugonia moths, which were defoliating shade trees, and that they did their work well, but

[14] Palmer, "The Danger of Introducing Noxious Animals and Birds," *Yearbook U. S. Dept. Agric. for* 1898, 106, 1899.

[15] Drummond, "Introduced Birds of New Zealand," *Condor*, XIV, 227, 1912.

[16] Wetmore, *U. S. Dept. Agric., Bull.* 326, 38, 67, etc., 1916.

[17] Palmer, "The Danger of Introducing Noxious Animals and Birds," *Yearbook U. S. Dept. Agric. for* 1898, 87-100.

[18] Barrows, et al., "The English Sparrow (*Passer domesticus*) in North America, Especially in its Relation to Agriculture," *U. S. Dept. Agric.*, Div. Econ. Orn. and Mam., *Bull.* 6, 1895, 110 pages.

they drove out other birds and thus caused an increase in the tussock moths, which for several years thereafter ravaged the trees.[19] This Sparrow is an excellent example not only of the danger of importing a species into a new country, but also of the effect upon a species of the intervention of man through his inventive genius. It has been noticed that in some cities there has been a marked decrease in the number of English Sparrows since motor-driven vehicles have so largely displaced horse-driven wagons and carriages. Bergtold's[20] explanation is probably correct. In the cities the Sparrows obtained most of their food from the waste grain of the street—the droppings of horses, and so on. This source of food has now practically disappeared from city streets as a result of the decreased use of horses and the surfacing of the streets of the cities with smooth pavements, which are kept clean. On the other hand, in many farming districts the Sparrows get their food from the grain stacks and fields and help themselves to grain thrown out for poultry, and are there still on the increase.[21]

Huey tells us that years ago the importation of cats and mice to the Island of Guadulupe, in the Pacific Ocean, created great havoc by introducing a new element to an island that had no native mammals. Later, goats were introduced and completed the devastation. The goats, being without natural enemies and having at first abundant food, increased so rapidly that they soon almost denuded the island of its vegetation, and, having greatly overpopulated the area and reduced their food supply, they themselves became dwarfed and the flesh became poorer in quality.[22]

The historic island of St. Helena was, at the time of its discovery, covered by a dense forest. More recently it has been described as a comparatively barren, rocky desert, because of its devastation by goats (introduced by the Portuguese) which, within 75 years, increased to thousands. They

[19] Forbush, *Mass. Dept. Agric., Bull.* 9, 35-36, 1921.
[20] Bergtold, *Auk*, XXXVIII, 244-250, 1921.
[21] Anthony, *Auk*, XXXVIII, 605-606, 1921.
[22] Huey, *Science*, n. s., LXI, 405-407, 1925.

browsed off the protective cover of vegetation, exposing the soil of the steep slopes to erosion, and soon bare rocks replaced the wooded hills.[23]

Years ago Sable Island, Nova Scotia, was overrun by rats. Cats were imported, became plentiful and got the rats under control, then began on the rabbits. Foxes were introduced to fight the cats. After getting rid of the cats the foxes attacked birds and their eggs. Then an appeal was made to the government to exterminate the foxes. Thus any importation may lead to a long chain of unexpected consequences. The Mynah, introduced into Fiji to destroy insects, has itself become a pest.[24] The Starling, introduced into Australia, New Zealand and Africa, has changed its habits and is accused of damaging grapes and other crops.[25]

Lantana is an introduced plant in the Hawaiian Islands. The Chinese Turtle-dove and the Indian Mynah were also imported, the latter for the purpose of fighting the army worms that are so destructive to sugar cane, in which it has proved highly efficient. Both birds, however, feed upon lantana seeds and distribute them, and thus have caused its rapid spread, so insects have been introduced to fight the lantana. What will be introduced later to fight the insects that have been imported to fight the lantana?

"Thus the process of introduction goes pyramiding, with no man able to foretell the eventual results." [26]

These and numerous other instances of similar nature illustrate the danger of unnecessarily disturbing Nature's adjustment, a danger not generally sufficiently realized.

Grinnell,[27] in his usual able manner, has called attention to some very real objections to the introduction of foreign game birds in order to provide more sport for the hunters, or to take the place of native species that are fast disappearing. He

[23] Palmer, *Yearbook U. S. Dept. Agric. for* 1898, 87-110.
[24] Stoner, *Auk*, XL, 328-330, 1923.
[25] Taylor, *Proc. Brit. Col. Entom. Soc.*, 1913, 41.
[26] McAtee, "Introduction upon Introduction," *Auk*, XLII, 160, 1925.
[27] Grinnell, *Science*, LXI, new series, 621-623, 1925.

says that the chief causes of the decrease in native game birds are excessive shooting in the more thickly populated regions and the diminishing food supply for some species of game birds. If the introduced species require the same sort of food as the somewhat closely related native species of the region, as is likely to be the case, obviously there will be competition disastrous to the weaker species. Therefore either the introduction will prove a failure, or if the introduced species thrives it will do so at the expense of the native birds. He mentions also the grave danger that in importing foreign birds some disease or parasite may be brought in that is not particularly injurious to the introduced species, which has by long association become partially immune, but may be very detrimental to native species. He says furthermore, with sound reason, that the country belongs as much to the nature lovers as to the sportsmen, and that the latter have no right to jeopardize native species without first consulting the thousands (doubtless greatly outnumbering the sportsmen) who are more interested in seeing and studying birds than in killing them. In fact, one great trouble with the game problem in the United States is that those who are interested in the lives of wild birds and mammals have turned over the matter of protecting them to those whose chief interest is in their death. Dr. Grinnell says that the introduction of a species "must bring dismay to every student whose concern extends to include the welfare and usefulness to man of California wild life generally and is not restricted to sport alone." This would apply equally well to any other state or region.

The evolution of species has been in progress for ages, and during all those ages species have been adjusting themselves to their natural environment. Birds were already well developed far back in geologic time. The Jurassic *Archæopteryx* was fully feathered and winged. As they became more diversified in structure and habit they came to occupy a more and more important place in the Balance of Nature. Their preservation is necessary not merely because some species are

insectivorous, others engaged in warfare against pernicious rodents, others devoted to the destruction of weed seeds; but also because their wholesale destruction, when not necessary, means a reckless disregard of Nature's immutable laws and a sad disarrangement of her adjustments, that can only be disastrous.

However, man has already so profoundly disturbed the equilibrium throughout the civilized world that he must ultimately assume effective and intelligent control of all wild life,[28] utilizing natural enemies of injurious species so far as possible, but keeping them under his direction and supplementing them by all the various artificial agencies at his command.

In America, though the disturbance by man began when the Indian first arrived,[29] their scattered numbers and the roving habits of many of the tribes prevented great changes as a result, except locally. With the coming of the white race a great and rapid transformation of the country began in earnest, with some sweeping changes in faunas and floras and profound disturbance of the equilibrium established by ages of natural development of organic interactions.

[28] Goldman, "The Predatory Mammal Problem and the Balance of Nature," *Journ. of Mammalogy*, VI, 28-33, 1925.
[29] Adams, *Journ. of Mammalogy*, VI, 83-96, 1925.

VI

CORRELATION OF STRUCTURE WITH FOOD HABITS

Throughout the animal world there is close relationship between physical structure and food habits. The philosophical naturalist sometimes finds it difficult to satisfactorily account for the origin of certain correlations, but whether the giraffe developed long fore-legs and neck because he was compelled to browse from tall trees, or developed the habit of thus browsing because his long fore-legs and neck made it inconvenient to feed upon herbs and low shrubs, or whether the correlation came about gradually through constant reaction of structure and habit upon one another—however he got that way, the correlation seems clear and plain. Many such correlations among birds are equally striking.

The hooked beaks and strong talons of Hawks and Owls are well adapted to seizing, holding and tearing the flesh of rabbits and other rodents upon which they feed, and not at all suited to feeding upon plant lice or mustard seeds. The closely related Vultures feed chiefly upon carrion and consequently have hooked beaks for tearing flesh, but have weaker feet because they have less need for strong ones. Their talons are modified to better enable them to walk on the ground and their heads are free from feathers. The Shrikes, otherwise quite different from the birds of prey, have a somewhat hooked beak, and feed to some extent upon mice and small birds, but their talons are not adapted to holding their prey while they tear it apart, so they have developed the curious habits of impaling their food upon thorns, which sufficed until modern civilization provided them with barbed-wire for the purpose.

The Great Blue Heron, with its long neck and legs and rapier-like bill, is admirably adapted to its habit of wading in shallow water and spearing fishes, amphibians and snakes. The Flamingo, also with long neck and legs, feeds largely upon mollusks and other invertebrates obtained from the bottom of the water, and accordingly has a very different bill. His feeding habits more closely resemble those of some Ducks than of the Herons, but obviously his long legs would make a Duck bill a very awkward tool for that purpose, so it differs almost as much from the Duck-like bill as from the Heron-like. Some of the shore-birds, living in similar places and having legs and necks as long in proportion to the size of the body, have developed bills well suited to probing deeply into the mud for worms and other buried food.

Most of the Ducks, having webbed feet and flat bills with comb-like processes along the margins, swim about and strain their food from the water or the mud at the bottom, which obviously a Heron, with his sort of bill, could not do. On the other hand, the Mergansers are fish-eating Ducks, and consequently have bills modified for the purpose of catching small fishes. Their bills are long, slender, strongly hooked at the end and set with tooth-like projections along the margins, to enable them to seize and firmly hold the slippery fishes.

The Swans have short legs and webbed feet, but long necks, enabling them to feed from the bottom of shallow water while swimming, without diving. Kingfishers and Ospreys both catch fishes, but one catches them with his bill, while the other catches them with his talons. Hence, as should be expected, the bills and feet of one are quite different from those of the other. Swifts and Hummingbirds belong to closely related families and both feed largely upon insects, but the former has broad, flat mandibles with wide gape suitable for catching their prey on the wing, while the Hummingbirds have slender bills suited to their habit of probing the depths of tubular flowers for tiny insects and nectar. Also correlated with the feeding habits of the Hummingbirds is their highly specialized

power of flying backwards and sideways, not possessed by other birds.

The Oyster-catchers belong to the shore bird group, but have developed a heavy, compressed bill, said to be used in opening the bivalved mollusks upon which they feed. Woodpeckers have two toes directed forward and two (or sometimes one) directed backward, which enables them to cling firmly to the bark of trees, their stiff tail feathers acting as props, while they drill holes with their chisel-like beaks, in search of the boring insects so injurious to trees. Furthermore, the tongues are highly specialized for the purpose of obtaining food.

In fact, the tongues of birds in general are so important in obtaining and utilizing food, and the food of different species differs so much, that many types of tongues have developed, with modifications adapted to various needs. Thus the Woodpeckers that obtain their food chiefly by boring into trees and thrusting the tongues into the burrows to draw out the boring insects, are provided with long, sharp tongues capable of great extension, armed with barbs, making them effective spears with which to pierce and firmly hold their hapless victims. The Flickers, in the same family, have adopted a diet consisting largely of ants, and correlated with this difference in habits (whether as cause, or effect, or neither, the reader may guess), they have acquired much more blunt tongues, with fewer barbs, than most of their closest relatives, and their tongues are well supplied with mucous, to enable them to catch and hold the ants. The Red-headed Woodpeckers (*Melanerpes erythrocephalus*), having a more general diet, their tongues are much less extensible and the barbs near the tips are replaced by hair-like processes. The Sapsuckers' (same family) tongues are still more reduced and otherwise modified. Birds that bolt their food (Booby, Pelican, Cormorant, etc.) usually have tongues of small size, without specialized structure. On the other hand, in many species of birds there seems to be no structural adaptation of tongues to habits. Also there is considerable variation in the tongues of some

closely-related species that presumably have very similar habits. The whole subject of bird tongues is highly interesting, and has been the theme of some excellent, well-illustrated publications.[1]

The Black Skimmer has the lower mandible of its bill an inch and a half longer than the upper mandible. It was long believed that this remarkable development, seemingly a deformity, was for the purpose of enabling the bird to skim its food from the water, as it has a habit of flying just above the surface of the water with the bill partly submerged, as though skimming the water for food. This has, however, been recently questioned. The habit of catching fishes in that way does not appear to be general enough to indicate that the peculiar bill is a case of specialization for that particular purpose,[2] though some positive statements of eminent ornithologists that they have seen the birds do so leave no doubt that it occasionally does catch fishes in just that way. Those who believe that all organic structures are utilitarian in their origin and purpose and must be accounted for may be compelled to seek some other explanation of this strange bill.

The utility of the enormously-developed bills of the Toucans is not at all clear, but certainly they are much better fitted for their food habits than would be the case if the birds fed upon ants or minute seeds, as some other birds do. The Snail Hawk, or Everglade Kite, feeds largely upon snails of the genus *Ampullaria* and has a highly specialized upper mandible in the form of a semicircular hook, very useful in extracting the large snails from their shells, while the claws are specially adapted to holding the snails.[3]

[1] See, for example: Lucas, "The Tongues of Woodpeckers, Relation of the Form of the Tongue to the Character of the Food," *U. S. Dept. Agric.*, Div. Ornith. and Mamm., *Bull.* 7, 35-44, 1895; "The Tongues of Birds," *Ann. Rept. U. S. National Museum for* 1895, 1003-1020; "The Taxonomic Value of the Tongue in Birds," *Auk*, XIII, 109-115, 1896. Gardner, "The Adaptive Modifications and the Taxonomic Value of the Tongue in Birds," *Proc. U. S. National Museum*, LXVII, 1-49, 1925.

[2] Arthur, *Auk*, XXXVIII, 566-574, 1921. Stone, *Auk*, XXXVIII, 595-596, 1921.

[3] Lang, *The Nautilus*, XXXVII, 73-77, 1924.

The Finches, Canaries, Sparrows and Grosbeaks have strong, conical bills with which to crack the hard seeds upon which they feed. The Crossbills, in the same family, received their name because their mandibles are crossed, a peculiarity generally considered an adaptation to their habit of feeding upon coniferous seeds, the deformity enabling them to easily extract the seeds from the cones, but it seems equally well adapted to another habit that has been observed—that of tearing insect galls apart to obtain the insects.[4] Yellow Warblers, often mistaken for "Wild Canaries," belong to an entirely different family, provided with bills quite suitable for picking up insects that constitute their chief food, but wholly unsuitable for cracking seeds. People who catch them, put them into cages and try to feed them bird seeds, wonder why they soon die.

A strange adaptation is that of the Polynesian Nutmeg Pigeon, which has a gizzard quite different from that of ordinary grain-eating birds, but admirably adapted to the grinding up of nutmegs upon which it feeds, whence its name.[5] Was this sort of gizzard developed because the bird eats nutmegs, or does it eat nutmegs because it has such a gizzard, or neither or both?

The Porto Rican Tanager is called the "Mistletoe Bird" because it feeds chiefly upon mistletoe seeds. Its stomach is unique among birds, so modified that it extracts the nutriment from the seeds without grinding them.[6]

The power and habits of flight of birds are also correlated with food habits. Could an Ostrich, or a Penguin or even a Swan become much of a flycatcher? How would a Nighthawk or a Chimney Swift fare if it were compelled to obtain its food as a Duck does? Could a Crow or Sparrow succeed in picking nectar and tiny insects from the flowers on the wing as the Hummingbird so easily does? Would it not be

[4] Taverner, *Condor*, XXIV, 96, 1922.
[5] Wood, *Auk*, XLI, 433-438, 1924.
[6] Wetmore, *Auk*, XXXI, 458-461, 1914.

interesting to see a Heron or a Parrot competing with the Swallows in capturing small insects on the wing?

All these differences in structure and methods of locomotion give to the birds great diversity of food habits, so that a large number of species of birds may subsist side by side without too serious competition, each group performing its own share of the work in keeping in check the various pests so injurious to farm and orchard crops and to forests. For this reason the birds hold a very important position in Nature.

VII

THE FUNCTION OF BIRDS IN NATURE

We have seen in another chapter how birds have frequently rescued crops and forests from local plagues of injurious insects and mammals, but their most important function is their continuous work in keeping pests in check and thus preventing the special outbreaks. Bryant, in praising the birds for their aid in the control of insect plagues in California, sounds this timely warning: [1]

"There is danger of overestimating the real economic value of birds at the time of an insect outbreak. On the other hand, however, there is little danger of overestimating the economic value of birds when insects are in normal numbers."

The reason of this is obvious. The fecundity of insects is remarkable; that of birds is comparatively very low. The offspring of a pair of insects of certain species, if unmolested, may in a single season number millions. The offspring of a pair of the most prolific birds in the same length of time would, by comparison, be quite insignificant. Under normal conditions there are enough birds, aided by other enemies and adverse weather, to keep the insects well under control. However, in unusual seasons, when weather and all other conditions are very favorable to the insects, they multiply with enormous rapidity, while their bird enemies, with their low rate of reproduction, remain numerically about stationary. If the area covered by the insect plague be not too large, enough birds may congregate from the surrounding region to control it. If the area be very large, manifestly that is impossible,

[1] Bryant, *Univ. Calif. Pub. in Zool.*, XI, 13, 1912.

in which case the birds may render such aid as their numbers and industry may permit, but cannot bring the uprising under control.

Because of the fact that injurious insects and mammals, normally kept within reasonable bounds, may, during especially favorable seasons, increase so rapidly as to become very harmful, the species of birds that have a mixed diet are particularly valuable. Though some species are quite limited in their food habits, it has been frequently observed that many other birds, though having their own favorite kinds of food, yet often turn to the kind of food that is most abundant at a particular time and place. For example, when flying insects are abundant many species, including Sparrows, Hummingbirds, Woodpeckers, Gulls, Terns, Warblers, Thrushes, Bluebirds, Solitaires, Nutcrackers and others, sometimes for the time being adopt the habit of Flycatchers and feed upon insects caught by them on the wing.[2]

It is their great diversity of food habits, their adaptability, enabling many species to adopt the food that is temporarily most abundant, and the ease with which they move from place to place, that give to birds a peculiar and important position in Nature which no other organisms can fill. Some species attack one pest, others feed upon another pest, while in time of local plagues many species join in the battle, rallying from other neighborhoods and moving readily from field to field, from orchard to orchard, ridding each of insects and other injurious organisms as they go. Their habit of flying considerable distances enables the insectivorous birds to discover where insects are most abundant and the birds of prey to find localities where harmful rodents are becoming plentiful. Hence their ability to gather at the point where their services are most needed.

[2] McAtee, *Auk*, XXXVII, 144-145, 1920. Forbush, *Auk*, XLI, 468-470, 1924. Beal, *U. S. Dept. Agric., Farmers' Bull.* 630, 1, 1915. McGregor, *Condor*, II, 33, 1900. Marsden, *Condor*, IX, 27, 1907. Storer, *Condor*, XXI, 125, 1919. Maillard, *Condor*, XXI, 212, 1919. Bassett, *Condor*, XXII, 37, 1920.

Furthermore, their diversity of food habits and adaptability make it possible for a large number of birds to live in a given region without too close competition for their own good and without becoming destructive, and thus to be ready to join in the suppression of any plague of other organisms. A bird that is largely vegetarian lives through the seasons of scarcity of insects and then adopts an insect diet when insects are abundant. On the other hand, some birds that are largely insectivorous are able to turn to a vegetable diet when insects are scarce, and thus save themselves for their attack upon insects when the latter become plentiful. If the majority of birds were strictly insectivorous, comparatively few would survive seasons unfavorable to insects, and consequently they would not be on hand to aid in the warfare during seasons favorable to insects. If all birds had a limited diet of the same sort of food they would soon destroy their food supply and reduce their own numbers.

It has been urged, as an objection to the preservation of birds, that many species of insects are predatory or parasitic on other insects; that such species destroy other insects and hence are themselves useful; that birds eat useful insects as well as harmful. All of this is true. The same argument applies with equal force to the use of artificial means of keeping insects in check. Sprays and fumigants destroy useful as well as harmful insects. It has even been declared that in order for a bird to be useful it must destroy 30 times as many harmful as useful insects. Beal has conclusively answered the argument by pointing out that if, for example, one-half of the individuals of each species of insect, both useful and harmful, were destroyed by the birds, it would leave entirely undisturbed the "internal relations of the insects among themselves." In other words, the various species of insects would still bear the same ratio one to another. The preservation of the balance, while reducing the total number, is the important service rendered. If birds fed only upon harmful insects, then the useful ones, with their wonderful fertility, relieved from

the attacks of birds, would soon increase to such numbers that they would become a terrible nuisance, until the destruction of their food supply would limit further increase and ultimately cause a decrease.[3]

"The true function of insectivorous birds is not so much to destroy this or that insect pest as it is to lessen the number of the insect tribe as a whole—to reduce to a lower level the great flood of insect life. That this is the true relation of birds and insects would be inferred from the fact that the two have lived together for countless ages, and the Balance of Nature has been preserved except as disturbed by the operations of man. Birds have not wholly destroyed predaceous and parasitic insects on the one hand, nor on the other have they, so far as we know, exterminated any vegetable-eating pest, but they have successfully held the balance between the two, and kept both at such a level of relative abundance as has subserved the best interests of both the animal and vegetable world; and it is only where man has interfered with this balance that oscillations have taken place which have resulted in damage to him and to the products of his labor."

[3] Beal, *Yearbook U. S. Dept. Agric. for* 1908, 347-350. See also Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 3, 90-93.

VIII

COMPLETE PROTECTION OF BIRDS NOT DESIRABLE

In the conservation of bird life, as in all other things, there may be danger of going to extremes. It is not at all desirable that any species of bird or other animal, however useful it may be, should be completely protected from its enemies. Such a course might result in its speedy extermination. In case of a very prolific species this might require but a few years, but even in case of the least prolific the end might not be long postponed. There is on the earth enough food to maintain only a certain amount of animal life of all sorts. For most species their food supply is still more limited by the fact that they are not omnivorous and are structurally unable to become so. Ducks cannot so change their habits as to subsist upon the tiny insects that infest the trees and shrubbery, which constitute so large a proportion of the food of Chickadees, Nuthatches and Creepers. Warblers would make a sorry mess of trying to live upon the hard seeds that the Canary cracks so easily with his strong bill. Wrens would not thrive if they had to depend for food upon catching rabbits and other mammals so easily captured and eaten by birds of prey.

If the rate of increase of a given species should become too rapid it would soon be too abundant, destroy its food supply and then perish, in the absence of other factors tending to preserve it. The very fact of a diminishing food supply would automatically limit the increase or weaken the race, or both. The weaker, under-nourished individuals would perish and the weakening of the more robust individuals would probably decrease their power of reproduction, more individuals

would become sterile, the young would not be so well cared for, and thus the total annihilation of the species would be retarded, if not prevented.

Extinction of species by overproduction may have occurred very often in the past ages. It is well known that hundreds of thousands of species have lived and been exterminated during the geological ages, as is abundantly and conclusively attested by their remains in the rocks. Various explanations have been offered for their extinction, such as epidemic diseases, the development of abundant and powerful enemies and wide-spread changes in climatic and physiographic environment. Doubtless all of these have been primary or contributing factors in the extermination of many species, but it is also quite possible that others have become extinct as a result of over-production, following the destruction of their natural enemies.

Pearson [1] has presented figures indicating that if complete immunity could be provided for a single pair of Robins and their offspring, including protection from adverse weather, enemies, accident and disease, so that neither the adults nor the young would die and reproduction would remain normal during the probable lifetime of the original pair, which he estimated at 14 years, their progeny would number 671,088,-640. Imagine, then, what would happen if all the thousands of pairs of Robins and their progency were thus immune!

As we have seen in another chapter, species and their enemies have developed side by side during the untold centuries of the past. The average rate of reproduction of each species and its death rate are approximately balanced. Too rapid a rate of reproduction would have resulted in over-populating the earth. Too rapid a death rate would in the course of time have exterminated the species. The enemies of each, including adverse weather, keep the species in reasonable check. If it becomes more abundant, its enemies, with more

[1] Pearson, "Conservative Conservation," *Bird-Lore*, XXVI, 452-455, 1924.

abundant food supply, increase in numbers or other enemies join in the attack.

It must be remembered, though, that in modern civilized communities few species are living under perfectly natural conditions. The conditions under which the interactions of species have developed—interrelations that required many centuries to reach their present status—have been profoundly altered. It will require a long time to restore the equilibrium. Meantime, in many cases man has added his ingenuity and modern facilities to the natural enemies of many species and in a few years has exterminated a considerable number of species, while others are fast going.[2]

It is quite evident that the important thing is not to give complete immunity to useful species, or to annihilate harmful ones, but to give to the useful species such protection as will enable them to maintain their proper numerical strength in proportion to other species, and on the other hand to assist the natural enemies of the so-called harmful species in keeping them within reasonable bounds without total extinction. It follows from all this that it may often be wise to reduce the numbers of certain very useful species, and perhaps in some cases even to encourage species that under normal circumstances might become harmful.

[2] This phase of the subject is more fully discussed in a later chapter.

IX

QUANTITIES OF FOOD REQUIRED BY BIRDS

In order to fully comprehend and appreciate the significance of food percentages in economic ornithology, it is quite necessary to understand that birds require a very much greater amount of food than do any other vertebrate animals, for several reasons.

The temperature and rate of respiration of birds are much higher than in case of mammals, the only other class of "warm-blooded" animals. A drop of a few degrees in the blood temperature of a warm-blooded animal, except in case of hibernation, is likely to prove fatal. Food is the fuel that maintains the temperature. This is true in the summer time, when atmospheric temperature is high, but still more food is required by Sparrows and other birds that winter in northerly regions.[1]

Adult birds are much more active than other vertebrates. The prodigious energy displayed by the buzzing wings of a Humming-bird as it hovers over a flower, the great distances traversed in an evening by a Nighthawk as it circles in search of insects, the speed maintained for long periods by a Teal Duck, grade through various species down to the more moderate movements of a Sparrow; but even the most sluggish birds are more active than other vertebrates. This is especially true when they are feeding their young, and so in some instances must gather many times as much food as the parents require for themselves. During this season their activity continues from dawn until dark. Imagine a horse or dog displaying as much energy in proportion to his size as one of the

[1] Judd, *Yearbook, U. S. Dept. Agric. for* 1898, 232.

more active birds, and the drain he would make upon the food supply! Food furnishes the motive power for all the activity displayed by birds and mammals alike, and strength to function as Nature intends they shall.

What nestling birds lack in activity they more than make up in rapidity of growth, which requires large quantities of food. Young birds must be fed very frequently. Close observation disclosed that a brood of Martins was visited with food 312 times in one day, Grosbeaks 426 times and Wrens 600 times.[2] Many such observations of other species, with similar results, may be found in the ornithological magazines. The number of broods of young varies with different species, but probably averages 2 or 3 broods of from 3 to 5 young each season, all requiring almost constant feeding during daylight hours until they leave the nest and begin to shift for themselves. At first the nestlings of many species consume as much as or more than their own weight in food each day, chiefly soft-bodied insects. They at first gain in weight at the rate of from 20% to 60% per day,[3] usually reaching adult weight in 4 to 5 weeks. In 8 days young Warblers under observation gained 4 times their original weight, Thrashers 5½ times, Wood Thrushes 5 times and Robins 8 times, while in 6 days Green Herons gained 6½ times their original weight.[4] A House Finch gains 60% in weight the first day and reaches 92% of its adult weight in 3 weeks.[5] Young Flickers gain in weight at the rate of 60% daily at first, the rate slowly diminishing until they leave the nest, in about 4 weeks.[6] Four Sparrow Hawks gained 9 times their original weight in 23 days.[7] Only very large quantities of food could produce such remarkable growth. The facts are more impressive if one tries to imagine a boy or a colt grow-

[2] Allen, *Cornell Reading-Courses*, IV, No. 76, 22-23, 1914.
[3] Judd, "The Food of Nestling Birds," *Yearbook U. S. Dept. Agric. for* 1900, 411, 435-436.
[4] Wheelock, *Auk*, XXIII, 435, 1906.
[5] Bergtold, *Auk*, XXX, 64-68, 1913.
[6] Sherman, *Wilson Bull.*, XXII, 169-171, 1910.
[7] Sherman, *Auk*, XXX, 417, 1913.

ing at such a rate and estimates the quantity of food it would require.

This brings us to the consideration of digestion. The bird's digestion of food proceeds rapidly and in case of insect food there is a very large amount of waste, thus requiring a great quantity of them to provide sufficient nutriment. Grains and other more concentrated food need not be taken in so large quantity. Birds with crops fill both crop and stomach with food about twice a day, while insectivorous birds probably fill their stomachs on an average 5 or 6 times daily.[8] Hence the food found in a bird's stomach and crop represents in one case about half and in the other only one-fifth or one-sixth of its food for the day. It is very important that this fact be kept in mind in considering the statistics of the subject. Experiments show that it requires young Meadowlarks from 3 to 4 hours to digest grasshoppers,[9] which would mean several meals a day during the long days of the grasshopper season. According to Allen [10] it requires only 30 minutes for some kinds of food to pass through the alimentary canal of a bird. A Shrike in captivity, when fed upon Maybeetles, disgorged the waste in 1 hour and 20 minutes, and when fed on a mouse digestion required 3 hours.[11] A Barred Owl digested 2 English Sparrows in 1½ hours, while a young Buzzard, "before it had a single feather," ate a house snake 3½ feet long, equal in weight to ⅕ that of the bird, and completely digested it in 1½ hours, as was learned by dissection.[12] Grains and hard seeds are digested much more slowly.[13] In case of the inactive, grain-eating domestic poultry in confinement, it requires from 11 to 24 hours.[14] Mearns found that 900 juniper

[8] Bailey, *U. S. Biol. Surv., Bull.* 22, 15, 1905.
[9] Bryant, "The Number of Insects Destroyed by Western Meadowlarks," *Science*, n. s., XXXVI, 874, 1912. See also *Univ. Calif. Pub. in Zool.*, XI, 7; *Univ. Calif. Agric. Exper. Sta., Bull.* 236, 11, 1913.
[10] Allen, *Cornell Reading Courses*, IV, No. 76, 21, 1914.
[11] Judd, *U. S. Biol. Surv., Bull.* 17, 102, 1902.
[12] Roddy, "Feeding Habits of Some Young Raptores," *Auk*, V, 244, 248, 1888.
[13] Bryant, *Univ. Calif. Pub. in Zool.*, XI, 7, 1912.
[14] Brown, "Digestion Experiments with Poultry," *U. S. Bureau of Animal Industry, Bull.* 56, 1904 (see especially pp. 77-78). Sayle,

berries passed through the digestive tract of a Bohemian Waxwing in 6 hours.[15]

The foregoing discussion prepares one for what might otherwise be startling figures on the actual quantities of food taken by birds.

A young Robin in captivity ate from 50 to 70 cutworms daily for 17 days, and when it weighed exactly 3 ounces it consumed 165 cutworms that weighed altogether 5½ ounces, nearly twice the weight of the bird.[16] If boys ate as much in proportion to their weight it would be much more difficult to pay the grocer's bills. Another Robin, on the 14th day of its life, ate 68 worms that weighed 41% more than the bird did.[17]

Audubon long ago reported that an American Merganser in captivity daily ate more than two dozen fishes each about four inches long, and was still hungry for more.[18] Two Bartramian Sandpipers in captivity averaged 202 locusts and other insects daily for 4 days.[19] One Flicker stomach contained 5,040 ants and 2 others contained about 3,000 ants each.[20] A Grackle contained 13 crayfishes.[21]

One Snowy Owl contained 14 white-footed mice and 3 meadow mice.[22] A Golden Eagle in captivity will consume 2 pounds of fresh meat daily.[23] A Cooper Hawk reared by Judd [24] frequently ate more than its weight of food in a day. Another was observed by Roddy [25] to devour 8 English Sparrows and a mouse in a day, and, until 10 weeks old, averaged

Auk, XLI, 475, 1924, citing Kaupp and Ivey, *Journ. Agric. Research*, XXIII, 721-725, 1923.

[15] Forbush, *Mass. Dept. Agric., Bull.* 9, 47, 1915.

[16] Nash, "The Birds of Ontario in Relation to Agriculture," *Ontario Dept. Agric.*, 28, 1898.

[17] Palmer, *Yearbook U. S. Dept. Agric. for* 1899, 261-262, citing Treadwell, *Proc. Boston Soc. Nat. Hist.*, VI, 386-399, 1859.

[18] See Bent, *U. S. Natl. Museum, Bull.* 126, 9, 1923.

[19] Aughey, *1st Rept. U. S. Entom. Comm.*, 343.

[20] Beal, "Food of the Woodpeckers of the United States," *U. S. Biol. Surv., Bull.* 37, 54, 1911.

[21] Beal, "Crow Blackbirds and their Food," *U. S. Biol. Surv., Bull.* 13, 63, 1900.

[22] Fisher, *Yearbook U. S. Dept. Agric. for* 1894, 226; *U. S. Div. Orn. and Mamm., Bull.* 3, 187, 1893.

[23] Oberholser, *U. S. Biol. Surv., Bull.* 27, 30, 1906.

[24] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 429.

[25] Roddy, *Auk*, V, 246, 1888.

8 English Sparrows a day, though a young Broad-winged Hawk never ate more than 5 in a day.

A Hummingbird daily ate twice its weight in sugar,[26] a concentrated food. An English Sparrow in captivity requires daily half its weight in grain [27] and must surely require more when it is active out-of-doors. One Quail stomach contained 10,000 pigweed seeds and another contained 5,000 pigeon-grass seeds.[28] A Ring-necked Pheasant contained 8,000 chick-weed seeds.[29] One Mourning Dove contained 7,500 sorrel seeds.[30] One Mallard Duck contained more than 75,000 seeds of bulrush and other sedges, primrose willow and duckweed; another contained 102,400 seeds of primrose willow, sufficient to seed 2½ acres of ground.[31]

A given number of insects or seeds found in a bird's stomach represents only one meal of a number taken during the day. A given number of insects, seeds or rodents taken by a bird does not mean merely the destruction of so many insects, seeds or rodents, but that the organisms thus destroyed are prevented from reproducing their kind and so multiplying by millions far into the future. Likewise the destruction of a useful bird does not mean merely one useful bird removed and its good work forever ended, but that all possibility of future progeny is at an end.

In this connection a brief comparison with the quantities of food taken by certain species of fishes, where the supply of food was abundant, is of interest. Bullheads consumed an amount equal to 55 per cent of their own weight in 24 hours; large-mouthed black bass 30 per cent; pumpkinseed 16 per cent; rock bass 10 per cent.[32] Possibly more extended observa-

[26] Sherman, *Wilson Bull.* XX, 162, 1913.
[27] Dearborn, *U. S. Dept. Agric., Farmers' Bull.* 493, 23, 1912.
[28] Judd, "The Economic Value of the Bob-White," *Yearbook U. S. Dept. Agric. for* 1903, 195.
[29] *U. S. Dept. Agric., Bull.* 513, 5, 1913.
[30] Judd, *Yearbook U. S. Dept. Agric. for* 1898, 332.
[31] McAtee, *U. S. Dept. Agric., Bull.* 720, 3, 1918.
[32] *California Fish and Game*, XI, 130-131, 1925, citing Pearce, "Amount of Food Eaten by Four Species of Fresh-water Fishes," *University of Wisconsin*, V, 254-258.

tions may prove that the discrepancy is not as great as these figures indicate. Fishes, like reptiles, are much more irregular in their feeding habits than are birds, and do not require as constant a supply of food. Hence the amount taken during a particular short period, though food is then abundant, is not indicative of the average amount required. Furthermore, the fish experiments were carried on necessarily under artificial conditions. The danger of conclusions drawn from such experiments is discussed elsewhere in this book. The foregoing statistics of the quantities of food taken by birds are largely based upon field observations and examination of the contents of stomachs of birds taken in the open, where they had been feeding under natural conditions, and the evidence is sufficiently abundant and convincing to leave no doubt as to the necessity of large quantities of food to sustain bird life.

X

METHODS OF INVESTIGATION

The primitive method of investigating the food habits of birds was by field observation. While that method brought forth some accurate information, yet inevitably in many cases it led to erroneous conclusions. If Hawks were frequently seen to carry off chickens it led to the general destruction of Hawks, without discriminating between species or ascertaining what species were the guilty parties. In fact, the large Hawks so commonly called Chicken Hawks and against which farmers have waged relentless warfare in many localities, are not the real Chicken Hawks at all.

If Blackbirds were seen digging about the roots of sprouting corn, it was naturally inferred, perhaps even demonstrated, that they were, at least to some extent, feeding upon the corn, but field observation alone could not inform the observer of the proportion of cutworms and other pests taken to pay for the corn. If Robins were seen picking cherries, it was easy to infer that their chief food was cherries, with no knowledge of the fact that to some extent they made the cherries possible by their police work in the prevention of the ravages of insects. Catbirds have been accused of pecking ripe tomatoes, but upon investigation it was discovered that domestic hens were the guilty ones. A Broad-winged Hawk was accused of stealing chickens, and shot, whereupon its stomach was found to contain only harmful beetles and part of a meadow mouse. Leaf material clinging to the bills of Siskins led to the natural inference that they were feeding upon green foliage, but investigation led to the fact that they were feeding upon sawfly grubs from galls attached to the leaves.[1]

[1] Bassett, *Condor*, XXV, 137-138, 1923.

On the other hand, however, field observations are often necessary to correct deductions naturally drawn solely from an examination of the contents of stomachs of birds. For example, orange seeds were found in the stomachs of Ruddy Quail-doves in Porto Rico, but observation showed that they feed upon the decaying oranges on the ground beneath the trees, which they could easily pick apart, not upon good fruit on the trees.[2] Verily, the analyst of bird foods needs very broad, as well as detailed, information concerning the environmental conditions in various localities at different times of the year, and the methods of feeding, of the species with which he must deal. It is a man-sized job. Hasty conclusions are dangerous.

As we have seen, naturalists are able to tell a great deal about the food habits of birds by their physical structure. The long legs and necks and spear-like beaks of Herons are closely adapted to their feeding habits. The various groups of Ducks have feet, and especially bills, suited to their several needs. The cracking of hard weed seeds, so easy for the Finches, with their stout, conical beaks, would be quite impracticable for the Warblers. With his chisel-like bill the Woodpecker readily sinks a shaft to the tunnel of a tree-boring larva and extracts the dainty morsel for his breakfast, while a Dove would have a sad time trying to get a square meal in that way.

It was at one time hoped that experiments upon captive birds would provide a large amount of accurate information on the food of wild birds, but they were found to be quite unreliable and misleading,[3] often flatly contradicted by the actual contents of the stomachs of the same species killed in the open. The reason of this is the impossibility of reproducing artificially anything approaching the natural environment of most wild birds and the fact that nothing else so changes animals' reactions to stimuli as imprisonment, even

[2] Wetmore, *U. S. Dept. Agric., Bull.* 326, 48, 1916.
[3] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, 86-87, 1880.

though not very closely confined. Birds in confinement regularly accept food that they cannot possibly find in their native haunts and reject food that is regularly taken under natural conditions. This has been repeatedly observed. For example, a Song Sparrow in captivity rejected two of his favorite kinds of seeds. A captive Green Woodpecker refused an earwig, but 23 of them were found in the stomach of a wild one. Bartlett reported that the Water Ousel in confinement seemed to prefer small fishes to all other food, but Newstead found no fish remains in the Ousels that had been feeding under natural conditions. Hummingbirds in captivity are usually fed upon sugar syrup, which they take with avidity, as they do also when they find it in the open. This has led many to believe that their natural food is nearly all nectar from flowers and sap from trees, but examination of 29 stomachs indicates that their food is largely insects, nectar and sap being secondary, the insects not merely taken accidentally in seeking the nectar and sap. Almost innumerable other instances are to be found in the ornithological and other zoological literature, showing the danger of accepting feeding experiments as a basis for conclusions as to the natural food habits of animals.

McAtee, in a very able review of the literature of experiments upon the food of various animals, including birds, in America and other countries, has shown how untrustworthy such experiments are. This paper should be carefully perused by every experimenter and student of animal behavior and economic ornithology. Among other things he says: [4]

"Doctor Judd was at one time very enthusiastic with regard to experiments in feeding birds, and these experiments [by the United States Biological Survey] were initiated and largely carried out by him. They were watched, however, and in part performed by Prof. F. E. L. Beal, the veteran economic ornithologist, who has examined the contents of more bird

[4] McAtee, "The Experimental Method of Testing the Efficiency of Warning and Cryptic Coloration in Protecting Animals from their Enemies," *Proc. Acad. Nat. Sci. Phila.*, LXIV, 281-364, 1912 (quotation from pages 332-333). Henderson, *Condor*, XV, 47-48, 1913.

stomachs than any other person in the world. Prof. Beal was mainly responsible for the discontinuance of these experiments, and I am betraying no secret in asserting that experimental ornithology was abandoned by the United States Biological Survey because of a direct realization from these trials of the futility of experiments as indications of the food preferences and, therefore, of the economic status of species under natural conditions."

Joffrey recently said: [5]

"A number of biologists are apparently of the opinion that studies carried on in glassware, greenhouses or laboratories have a fundamental value and transcend in importance other kinds of biological investigation. It is necessary, however, to correlate the results seen at best, but darkly, in the glass experimental houses, with those obtained in the open—in other words, in Nature."

It seems obvious that, as the actual contents of the stomachs of birds taken under natural conditions is conclusive of the food they eat under such conditions, if the results of experiments must, before they are accepted, be compared with the result of the stomach examinations, then the experiments are not worth while for the purpose of proving the natural foods of birds, whatever other value they may have.

The final test of the food habits of birds is the contents of their stomachs. From a decision based upon such evidence, provided a sufficient number of stomachs from a large number of localities, taken under natural conditions, are examined with thoroughness, there can be no appeal. It has often been asserted that certain insects are not taken by birds or other enemies because they are concealingly colored and escape observation; that others are not taken because they are protected by bristles or other armor; that insects such as blister beetles and stink bugs, are not taken because they possess irritating and nauseating secretions; but actual examination of the contents of bird stomachs has shown conclusively that all these types of insects are taken regularly and in fair

[5] *Science*, n. ser., LXII, 5, 1925.

quantities by some species of birds. Indeed, it seems quite certain that immunity from enemies would not be good for any species.

The work of examining thousands of bird stomachs has been done by comparatively few people, chiefly because of the difficulties that beset the workers. The great variety of material consumed by birds requires an intimate knowledge of a great many different kinds of insect, plant and other material. A large proportion of the contents of stomachs is in fragmentary condition, requiring much experience and a great deal of skill for its correct determination, and painstaking care in separating the different kinds.[6]

As many birds, within certain limits, turn to the kind of food most abundant at a particular time and place, analyses of the stomach contents of a given species may not always produce the same results, hence the necessity of obtaining large numbers of stomachs taken at different seasons and at many widely-separated localities. It is also highly important, in many cases, to know something of the local feeding grounds of the birds examined. For instance, 13.09% of the food of some Snow Buntings taken in stubble fields during the winter was wheat and 4.72% was other grains, nearly all waste grain, while other stomachs of the same species taken during the summer, while the grain was growing, yielded only 1.16% grain. The feeding habits of the birds must also be considered. Grain found in the stomachs or crops of habitual ground feeders is most likely to be waste grain, while that found in small birds that do not habitually feed upon the ground may be good grain taken from the stalks.

In the literature of ornithology it is customary, for the sake of brevity and convenience, to include, under the term stomach, the crop (of such species as have one), the throat, etc. In case of many insects, even small fragments of the hard parts remaining after the soft parts have been digested, may

[6] For methods and difficulties see Judd, *U. S. Biol. Surv., Bull.* 15, 12-16, 1901. Also McAtee, "Methods of Estimating the Contents of Bird Stomachs," *Auk*, XXIX, 449-464, 1912.

be accurately identified, so that the insects may at least be placed in their proper families and often genera, and in many cases they may be specifically determined. The work of sorting and determining miscellaneous material in such condition, often under a lens or a compound microscope, is exceedingly tedious. Nevertheless, between 50,000 and 100,000 stomachs have been thus examined by the investigators connected with the United States Biological Survey alone, which has been pre-eminent in such work, besides thousands of others examined by independent workers in America. The net result of all this work is to convince ornithologists and most other naturalists that nearly all native species of birds should be given some degree of protection, and that many of them, because so rigorously kept in check by their natural enemies, or because altered environment due to encroaching civilization has made such serious inroads, should be given almost complete protection from human enemies. Through both field observation and laboratory investigations a large fund of accurate information has been accumulated, showing definitely what species are useful and what ones are neutral or more or less harmful. These results should not be lightly set aside in special cases, but only upon very definite evidence that the special cases are exceptions to the general rule.

XI

BIRDS AS ENEMIES OF INJURIOUS INSECTS

In a preceding chapter the work of birds in checking great plagues of insects and rodents has been discussed, but their services in keeping such pests in check at all ordinary times and thus preventing destructive outbreaks are even more important. To fully appreciate such services, especially in connection with injurious insects, three things should be kept clearly in mind: (1) The large amount of food required by birds, in proportion to their size, a matter more fully discussed in another chapter. (2) The large ratio of waste material in insects, which requires a great quantity of them to provide a comparatively small amount of nutriment. (3) The astonishing rate of reproduction among insects, which would soon overpopulate the whole surface of the earth, were it not for the numerous checks upon their increase, none of which can well be spared and among which birds occupy a very prominent position.

The rate of increase of some insects is almost incomprehensible. Murray [1] has estimated that the offspring from a house fly, allowing only 1 out of every 12 eggs to develop, would reach the almost incredible number of 7,600,000,000 during the five months from April 10 to September 10. According to Collinge,[2] if all the eggs of a hop aphis should hatch and all the individuals survive, each female producing its complement, the 12th generation (13 generations per annum) would number 10,000,000,000,000,000,000,000 individuals. Obviously a large proportion of them must be destroyed

[1] Murray, *Popular Mechanics*, June, 1912, 793.
[2] Collinge, *Ann. Rept. Smithsonian Inst. for* 1919, 351.

in one way or another, and some species of birds are known to be destroying large numbers of aphids. No agency engaged in keeping these insects in check can be spared. Buckland [3] says that a single pair of potato beetles would produce 60,000,000 offspring in a single season, if unchecked. Certain species of birds feed upon these beetles, and cannot be spared, but the fecundity of the insects and the great increase in the supply of their favorite food render all their natural enemies inadequate, so that artificial means of combating them are necessary. This is true of many other insects. The rate of increase of all destructive insects is so high that, if unchecked by adverse weather and enemies of all kinds, parasitic and predatory, the insects would soon destroy practically all vegetation, unless their very numbers should act as an efficient check upon further increase.

With the fecundity of insects in mind and their consequent potential capacity for destruction, we may now for a moment consider the actual damage they do even with all the checks upon their increase in full operation. Buckland says that the daily ration of a caterpillar is twice its own weight of leaves, and that if a horse should eat at the same rate he would consume a ton of hay in 24 hours. He quotes Forbush to the effect that a certain flesh-eating larva will consume in 24 hours 200 times its own original weight, which would be equivalent to a human infant eating 1,500 pounds of beef during the first day of its existence. He cites Trouvelot as authority for the statement that the food taken by a single silkworm in 56 days equals 86,000 times its own original weight.[4] What destruction would be wrought by insects were it not for their numerous enemies!

It was estimated in 1921 that insects annually destroy one billion dollars' worth of forest and agricultural products in the United States and that but for the birds the damage would be $444,000,000 more annually [5]—damage reduced about 28

[3] Buckland, *Ann. Rept. Smithsonian Inst. for* 1913, 440.
[4] Buckland, *Ibid.*
[5] Forbush, *Mass. Dept. Agric., Bull.* 9, 15, 63, 1921.

per cent by the activity of the birds. Good business sense dictates the reasonable protection of creatures responsible for such a saving. Another estimate of the destructiveness of insects in the United States places it at $20 per year for every man, woman and child in the country,[6] or more than two billion dollars. It is reported that the annual loss caused by insects in this country increased from $300,000,000 in 1863 to $800,000,000 in 1904,[7] and has continued to increase.

According to Forbes, in Illinois the birds destroy about 70 per cent of the annual insect crop,[8] which surely must act as a very effective check upon their increase. Attwater, in an address to a Farmers' Congress, declared that the birds in Texas require about 35,500 bushels of insects for food per day, and added that the estimate is too low at that.[9] Think of all the damage those insects and their progeny, coming on in an unending and rapidly increasing procession, would do if permitted to live! Bryant [10] says that the Meadowlarks alone in the Sacramento Valley, California, consume 193 tons of insects daily in feeding their young during the nesting season.

Many years ago it was estimated that the annual damage done to the apple crop by the codling moth in the United States was from $12,000,000 to $15,000,000.[11] At least 36 species of birds are known to feed upon the codling larvæ, destroying in some localities from 66 per cent to 85 per cent of the insects, according to McAtee, who says: [12]

"Since 1746 nearly all entomologists who have published accounts of the codling moth have paid high tribute to its avian enemies, and they are almost unanimous in declaring birds to be the most efficient natural enemies."

[6] Science News Supplement, *Science*, n. s., LX, Nov., 1924, xiv.
[7] Sullivan, "The Economic Value of Bird Life," Extension Dept. Kansas Agric. College, *Agricultural Education*, III, No. 7, 11.
[8] Forbes, *Bull. Illinois State Lab. Nat. Hist.*, 1, No. 3, 86-87.
[9] Attwater, *The Relation of Birds to the Farmer*, 8, 1902.
[10] Bryant, Univ. Calif., *Agric. Exper. Sta., Bull.* 236, 1913.
[11] Quaintance, *Yearbook U. S. Dept. Agric. for* 1907, 435.
[12] McAtee, *Yearbook U. S. Dept. Agric. for* 1911, 237, 243-245.

True, with the vast increase in acreage of orchards the birds are not able to control the pests, but nevertheless they render valiant service to the orchardists in destroying a large percentage of the insects.

In a badly canker-infested apple orchard in Illinois it was observed that a large number of species of birds had gathered to feast upon the insects. One year 31 species were seen thus engaged and in another year 35 species. To ascertain definitely just what food they were taking, 146 of the birds, representing nearly all the species, were shot, and it was found that 35 per cent of the contents of all their stomachs consisted of canker worms.[13]

On a Maryland farm it was learned by 7 years of observation and investigation, including the examination of 645 stomachs of various species of birds, that 60.41 per cent of all their food was insects and their allies, and during a sawfly outbreak 7 out of 15 stomachs contained those destructive insects.[14]

Forbes collected a large number of birds in a canker-infested orchard and other specimens of the same species elsewhere and compared the contents of their stomachs. He found that in every instance the caterpillar element of food of those collected in the orchard was, on account of the abundance of canker worms and cutworms, much greater than those collected elsewhere. The respective percentages of caterpillars are as follows: [15]

	Specimens from orchard	Specimens from elsewhere
Robin	54%	23%
Catbird	26%	12%
Dickcissel	88%	47%
Indigo Bunting	29%	19%

[13] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, 4-6, 20-21.
[14] Judd, *U. S. Biol. Surv., Bull.* 17, 41, 1902.
[15] Forbes, "The Regulative Action of Birds upon Insect Oscillations," *Bull. Illinois State Lab. Nat. Hist.*, I, No. 6, 3-32, 1883.

Among the very destructive insects are the scales. As early as 1906 it was known that at least 64 species of birds eat the scales, distributed as follows: [16]

Woodpeckers 9 species	Sparrows 8	Creeper 1
Waxwings 8	Vireos 6	Nuthatches 2
Jays 2	Warblers 11	Tits 8
Orioles 3	Wrens 2	Kinglet 1
Thrush 1	Bluebird 1	Gnatcatcher 1

During an aphid outbreak in North Carolina it was estimated that 7 species of the Finch family on one farm consumed 932,205 aphids daily.[17]

The Colorado potato beetle is eaten by many birds, including the following: [18]

Rose-breasted Grosbeak	Quail	Nighthawk
Grouse, various species	Cuckoo	Crow
Red-tailed Hawk	Cardinal	English Sparrow
Thrushes 3 species	Robin	Scarlet Tanager

It is said that the mosquitoes that disturbed the Lyceum entertainments at Lake Winona, Indiana, disappeared after a large number of Purple Martins were encouraged to nest in boxes provided for them.[19]

Widespread and disastrous outbreaks of the imported grain aphis occurred in Kansas, Oklahoma and Texas in 1890, 1901, 1903 and 1907, causing a shortage of many millions of bushels in the wheat crop. Many species of birds aided in the suppression of the insects. Examination of the stomachs of birds taken in and about the fields proved that the aphids constituted the following percentages of the food of the various species at that time: [20]

Goldfinch 82.75	Vesper Sparrow 19.5
Savannah Sparrow 25.3	Chipping Sparrow 94.75
Field Sparrow 96	Junco 5.2
Song Sparrow 80	Titlark 70

One Pine Siskin contained 80 of the aphids.

[16] McAtee, "Birds that Eat Scale Insects," *Yearbook U. S. Dept. Agric. for* 1906, 189-198.
[17] McAtee, *Yearbook U. S. Dept. Agric. for* 1912, 397-404.
[18] McAtee, *U. S. Biol. Surv., Bull.* 32, 47, 1908.
[19] Forbush, 4th Ann. Rept. *Mass. State Ornithologist*, 21, 1912.
[20] McAtee, *Yearbook U. S. Dept. Agric. for* 1912, 397-404.

In the investigation of the imported alfalfa weevils that were devastating the fields in Utah it was found that 45 different species of birds, including some that are usually considered seed-eaters, were feeding upon the weevils, which constituted the chief part of the food of some of the birds.[21]

Some years ago when shade trees at Colorado Springs were threatened with ruin by the cottony scale, Red Polls and Pine Siskins were found to be feeding extensively upon the scales,[22] and these and other birds were doubtless largely responsible for the control of this pest there and in other Colorado cities. In England birds of the genus *Parus* feed freely upon closely related scales and aid in keeping them in check.[23] Howell has listed 96 species of birds known to eat the destructive cottonboll weevils.[24]

Ants are often a great nuisance and in some places they are very destructive. Bequeart, in a recent discussion of bird enemies of ants, tells of 3 species of African birds that follow the columns of driver ants, destroying large numbers of them.[25] In Australia 73 species of birds are known to feed upon ants.[26] Ants are found in the stomachs of many birds in the United States, chief among which is the Flicker. In a single Flicker stomach 5,000 ants were found and in two others 3,000 each.

Among the most destructive insects are the grasshoppers and locusts. The relation of birds to these pests has been the subject of a great deal of investigation in the United States and other countries. The results of some of these investigations have been mentioned in a former chapter, others follow.

At least 24 species of locust-eating birds have been identi-

[21] Kalmbach, "Birds in Relation to the Alfalfa Weevil," *U. S. Dept. Agric., Bull.* 107, 1914.
[22] Arnold, *Auk*, XXIX, 113, 1912.
[23] Cockerell, *Auk*, XXIX, 400-401, 1912.
[24] Howell, *U. S. Biol. Surv., Bull.* 29, 30-31, 1907.
[25] Bequeart, "The Predaceous Enemies of Ants," *Bull. Amer. Mus. Nat. Hist.*, XLV, 271-331, 1922 (bird enemies, 297-314). McAtee, *Auk*, XL, 162, 1923.
[26] Cleland, "The Food of Australian Birds," New South Wales Dept. Agric., *Science Bull. No.* 15, 1918. McAtee, *Auk*, XXXVII, 168, 1920.

fied in the Philippine Islands, including, among others, various species of Herons, Hawks, Pheasants, Finches, Ducks, Kingfishers, Crows, and so forth.[27] Many other species have been observed eating the locusts in those islands, but have not been taken for identification. It was noticed in the Eastern United States in 1919, in localities where the periodical cicada was very abundant much less damage than usual was done to the cherries, because the birds fed upon the insects.[28]

During August in certain portions of the United States most birds subsist to a great extent upon grasshoppers.[29] Here are some of the percentages of grasshoppers found in stomachs of various species of seed-eating birds taken from May to August: [30]

Dickcissel 41
Lark Sparrow 31
Chipping Sparrow 21
Grasshopper Sparrow 37
Song Sparrow 17
Vesper Sparrow 23
Field Sparrow 13

Bryant [31] has in several papers discussed in detail the effective work of birds as destroyers of grasshoppers. During one outbreak of the insects in California it was estimated that in each square mile 13 species ate 120,445 grasshoppers per day. Of 17 species of birds examined, all but 2 contained grasshoppers, which constituted the following percentages of their food: [32]

Killdeer 100
Western Kingbird 67.5
Black Phoebe 50
Bicolored Blackbird 97
Brewer's Blackbird 80
Bullock's Oriole 92
Anthony's Green Heron 15
Burrowing Owl 90
California Horned Lark 7.5
Western Meadowlark 96
English Sparrow 2
California Shrike 47

[27] Mackie, *Philippine Agric. Review*, VI, 541, 1913. McAtee, *Auk*, XXXI, 270-271, 1914.
[28] McAtee, *Auk*, XXXVII, 144-145, 1920.
[29] Beal, U. S. Dept. Agric., *Farmers' Bull.* 54, 16, 1898.
[30] Judd, "The Relation of Sparrows to Agriculture," *U. S. Biol. Surv., Bull.* 15, 62, 1901.
[31] Bryant, "Birds as Destroyers of Grasshoppers in California," *Auk*, XXXI, 168-177, 1914.
[32] Bryant, *Univ. Calif. Pub. Zool.*, XI, 8, 9, 1912.

During the great invasion of Rocky Mountain migratory locusts on the western prairies and plains of the United States from 1873 to 1876, Aughey made a close study of the relation of birds to insects in Nebraska, and his report thereupon is a classic.[33] He definitely reports 202 species of birds feeding upon the locusts and their eggs. About half of his records are based upon actual count of the locusts in the stomachs of the birds. A very large percentage of the stomachs contained over 25 of the insects and a considerable number contained over 60. Many other species elsewhere are now known to take locusts. As Aughey's report has long been out of print, is inaccessible to many bird students, and the relation of birds to locusts and their allies is a very important matter, the following summary of his data has been tabulated, giving the average number of Rocky Mountain locusts in the stomachs of the various species (including in a few instances other members of the locust family), the average number of other insects, besides other food, the "X" being used where the actual number is not designated and in a few instances percentages being indicated instead of actual numbers: [34]

Species of birds	Number of stomachs examined	Average number of locusts	Average number of other insects	Seen eating locusts	Average number of seeds and grains	Other food
Eared Grebe	2	7	x	...	x	Crayfish, fish
Pomarine Jaeger	1	few	..	..	..	Crayfish, frogs, fish
Great Black-backed Gull	1	few	x	..	..	Fish, frogs
Herring Gull	2	6	..	..	..	Fish, mollusks
Ring-billed Gull	6	6	14	..	..	Fish, frogs, mollusks, etc.
Franklin Gull	10	21	11	..	..	Crayfish, vertebrates
Forster Tern	2	8	..	..	..	Crayfish, fish, lizard
Least Tern	8	19	15	..	..	Crayfish, etc., vertebrates
Black Tern	6	38	15	..	..	Crayfish, etc., vertebrates
White Pelican	5	21	19	..	..	Crayfish, fish, frogs
Mallard	10	22	26	..	..	Mollusks, etc.
Black Duck	1	16	30	..	x	Grass

[33] Aughey, "Notes on the Nature of the Food of the Birds of Nebraska," 1st Ann. Rept. *U. S. Entom. Comm.* (for the year 1877), "Relating to the Rocky Mountain Locust," Appendix II, 13-62, 1878. Reprinted as unclassified Pub. No. 14, *U. S. Geol. and Geog. Surv. of the Territories* (Hayden Survey).

[34] Reprinted from Henderson, *Univ. Colo. Bull.*, XIII, No. 4, 1913.

Species of birds	Number of stomachs examined	Average number of locusts	Average number of other insects	Seen eating locusts	Average number of seeds and grains	Other food
Green-winged Teal	9	5	38	..	..	Mollusks, etc.
Blue-winged Teal	1	37	22	..	x	Mollusks
Shoveller	1	32	28	..	x	Mollusks
Pintail	7	11	34	..	..	Mollusks, etc.
Wood Duck	9	15	23	..	..	Mollusks, etc.
Bufflehead	4	10	22	..	x	Mollusks
Ruddy Duck	1	31	20	..	..	Mollusks
Lesser Snow Goose	8	30	33	..	..	Mollusks, grass
Canada Goose	9	31	42	..	..	Mollusks, grass
Bittern	1	16	..	..	..	.....
Great Blue Heron	1	11	..	..	..	Fish, frogs
Sandhill Crane	4	66	50	..	x	.....
King Rail	7	33	30	..	x	.....
Black Rail	1	11	27	..	x	.....
Florida Gallinule	1	7	29	..	x	.....
Coot	9	23	29	..	..	Mollusks
Wilson's Phalarope	8	..	56	..	..	.....
Avocet	2	50%	50%	..	..	.....
Woodcock	1	32	x	..	..	.....
Wilson's Snipe	11	38	23	..	..	.....
Dowitcher	6	[illegible]	54	..	..	.....
Knot	1	11	many	..	..	.....
Baird's Sandpiper	5	[illegible]	34	..	..	.....
Least Sandpiper	8	18	26	..	..	.....
Semipalmated Sandpiper	2	..	x	..	..	.....
Marbled Godwit	6	7	36	..	..	.....
Greater Yellowlegs	6	..	50	..	..	.....
Yellowlegs	5	12	31	..	..	.....
Solitary Sandpiper	2	5	38	..	..	.....
Bartramian Sandpiper	22	37	16	..	..	.....
Buff-breasted Sandpiper	1	42	few	..	..	.....
Spotted Sandpiper	6	15	23	..	..	.....
Long-billed Curlew	10	48	15	..	12	.....
Eskimo Curlew	1	31	..	..	..	Many berries
Black-bellied Plover	2	full	few	..	..	.....
Golden Plover	4	many	many	..	..	.....
Killdeer	9	29	21	..	few	.....
Semipalmated Plover	11	38	19	..	..	.....
Belted Piping Plover	4	26	32	..	..	.....
Mountain Plover	16	47	13	..	..	.....
Bob-white	21	25	14	..	x	.....
Prairie Hen	21	41	10	..	x	.....
Prairie Sharp-tailed Grouse	10	17	9	..	x	.....
Sage Grouse	4	47	3	..	..	Sage leaves
Wild Turkey	6	43	18	..	23	.....
Passenger Pigeon	6	8	2	..	x	.....
Mourning Dove	6	1	3	..	57	.....
Swallow-tailed Kite	3	43	27	..	..	.....
Marsh Hawk	6	41	26	..	..	Gopher, reptiles
Cooper's Hawk	6	few	..	..	..	Mammal, birds
Goshawk	1	few	..	..	..	Rabbit, quail
Red-tailed Hawk	1	..	37	..	..	Quail
Swainson Hawk	4	33	31	..	..	Mammals
Rough-legged Hawk	1	..	70	..	..	Gopher, lizard
Prairie Falcon	1	16	..	..	..	Bird
Pigeon Hawk	6	few	..	..	..	Birds
Richardson's Merlin	2	..	12	..	..	Birds
Sparrow Hawk	10	5	31	..	..	Vertebrates
Barn Owl	3	13	39	..	..	Mice
Long-eared Owl	1	..	few	..	..	Rabbit
Short-eared Owl	2	15	8	..	..	Rabbit, gopher
Barred Owl	..	..	..	x	..	.....
Screech Owl	8	27	27	..	..	Bird, mice

Species of birds	Number of stomachs examined	Average number of locusts	Average number of other insects	Seen eating locusts	Average number of seeds and grains	Other food
Great Horned Owl	1	..	30	..	..	Gopher
Snowy Owl	4	2	..	..	..	Birds, mammals
Burrowing Owl	9	34	23	..	..	Vertebrates
Yellow-billed Cuckoo	10	41	15	..	..	.....
Black-billed Cuckoo	1	41	..	..	..	.....
Belted Kingfisher	2	16	..	..	..	Fish
Hairy Woodpecker	6	26	32	..	..	.....
Downy Woodpecker	4	41	20	..	..	.....
Yellow-bellied Sapsucker	5	26	17	..	..	.....
Red-headed Woodpecker	6	25	35	..	7	.....
Red-bellied Woodpecker	2	50%	50%	..	..	.....
Northern Flicker	8	29	25	..	4	.....
Red-shafted Flicker	1	18	31	..	..	.....
Whip-poor-will	2	full	..	..	..	.....
Poor-will	1	80%	..	..	..	.....
Nighthawk	7	51	12	..	..	.....
Chimney Swift	x	x	x	..	..	.....
Ruby-throated Hummingbird	1	4	..	..	..	.....
Kingbird	8	27	32	..	few	.....
Arkansas Kingbird	..	..	..	x	..	.....
Crested Flycatcher	1	23	58	..	..	.....
Phœbe	9	23	21	..	few	.....
Say Phœbe	1	32	..	..	..	.....
Olive-sided Flycatcher	1	17	x	..	..	.....
Wood Pewee	1	7	many	..	..	.....
Western Wood Pewee	1	22	..	..	..	.....
Yellow-bellied Flycatcher	1	16	x	..	..	.....
Least Flycatcher	4	10	15	..	..	.....
Horned Lark	1	42	..	..	33	.....
Magpie	1	1	x	..	..	.....
Blue Jay	1	45	..	..	x	.....
Raven	1	12	many	..	x	.....
Crow	x	x	x	..	..	.....
Clarke's Crow (Nutcracker)	1	41	..	..	x	.....
Bobolink	6	7	9	..	many	.....
Cowbird	x	..	x	x	..	.....
Yellow-headed Blackbird	20	7	37	..	19	.....
Red-winged Blackbird	x	..	x	x	x	.....
Meadowlark	9	23	8	..	many	.....
Orchard Oriole	2	75%	..	..	..	.....
Baltimore Oriole	..	..	..	x	..	.....
Bullock's Oriole	1	35	3	..	x	.....
Rusty Grackle	x	80%	x	..	few	.....
Brewer's Blackbird	x	75%	x	..	few	.....
Purple Grackle	x	many	x	..	..	.....
Evening Grosbeak	1	2	..	..	many	.....
Pine Grosbeak	5	eggs	..	..	x	.....
Purple Finch	1	eggs	..	..	..	.....
Gray-crowned Leucosticte	2	1	..	..	many	.....
Red-poll	4	eggs	..	..	many	.....
Goldfinch	3	8	..	..	..	.....
Snowflake	6	eggs	..	..	..	.....
Lapland Longspur	5	eggs	..	..	many	.....
Chestnut-collared Longspur	6	14	..	..	many	.....
McCown Longspur	2	5	1	..	..	.....
Vesper Sparrow	5	13	..	..	x	.....
Grasshopper Sparrow	7	7	x	..	x	.....
Henslow Sparrow	1	13	x	..	many	.....
Lark Sparrow	6	15	11	..	many	.....
Harris Sparrow	1	14	5	..	many	.....
White-crowned Sparrow	1	11	x	..	..	.....
White-throated Sparrow	5	20	14	..	..	.....
Tree Sparrow	1	13	1	..	many	.....

Species of birds	Number of stomachs examined	Average number of locusts	Average number of other insects	Seen eating locusts	Average number of seeds and grains	Other food
Chipping Sparrow	x	few	..	..	..	.....
Clay-colored Sparrow	1	9	..	..	many	.....
Slate-colored Junco	1	14	1	..	many	.....
Song Sparrow	2	6	8	..	..	.....
Lincoln Sparrow	1	11	3	..	..	.....
Towhee	3	11	few	..	many	.....
Cardinal	4	12	10	..	..	.....
Rose-breasted Grosbeak	2	12	..	..	..	.....
Black-headed Grosbeak	2	12	..	..	many	.....
Blue Grosbeak	1	3	12	..	many	.....
Indigo Bunting	2	5	4	..	many	.....
Dickcissel	5	21	7	..	many	.....
Lark Bunting	9	14	..	..	..	.....
Western Tanager	1	13	many	..	..	.....
Scarlet Tanager	1	37	..	..	..	.....
Purple Martin	10	26	16	..	..	.....
Cliff Swallow	8	30	14	..	..	.....
Barn Swallow	7	20	19	..	..	.....
Violet-Green Swallow	1	23	17	..	..	.....
Bank Swallow	5	20	21	..	..	.....
Bohemian Waxwing	1	eggs	..	..	..	.....
Cedar Waxwing	1	17	..	..	many	.....
Northern Shrike	1	14	..	x	..	.....
White-rumped Shrike	3	32	..	..	..	Birds
Red-eyed Vireo	x	many	..	..	..	.....
Philadelphia Vireo	4	11	16	..	..	.....
Warbling Vireo	..	..	..	x	..	.....
Blue-headed Vireo	1	50%	50%	..	..	.....
White-eyed Vireo	..	..	..	x	..	.....
Black-and-White Warbler	1	41	12	..	few	.....
Prothonotary Warbler	..	..	..	x	..	.....
Worm-eating Warbler	..	..	..	x	..	.....
Blue-winged Warbler	..	..	..	x	..	.....
Nashville Warbler	1	21	few	x	..	.....
Tennessee Warbler	..	..	..	x	..	.....
Parula Warbler	..	..	..	x	..	.....
Yellow Warbler	7	11	25	..	..	.....
Black-throated Blue Warbler	1	23	15	..	..	.....
Myrtle Warbler	1	31	5	x	..	.....
Magnolia Warbler	1	23	17	..	..	.....
Cerulean Warbler	..	..	..	x	..	.....
Chestnut-sided Warbler	1	17	21	..	..	.....
Bay-breasted Warbler	1	19	22	..	..	.....
Black-poll Warbler	4	30	12	..	..	.....
Yellow-throated Warbler	1	15	24	..	..	.....
Black-throated green Warbler	5	25	21	..	..	.....
Pine Warbler	4	11	..	..	..	Locust Eggs
Palm Warbler	2	16	few	..	..	Locust Eggs
Prairie Warbler	8	14	17	..	..	.....
Ovenbird	6	18	15	..	..	Locust Eggs
Waterthrush	1	19	30	..	..	.....
Louisiana Waterthrush	1	13	37	..	..	.....
Kentucky Warbler	1	9	many	..	..	.....
Macgillivray's Warbler	..	..	..	x	..	.....
Maryland Yellowthroat	1	8	..	x	..	.....
Yellow-breasted Chat	..	..	..	x	..	.....
Hooded Warbler	..	..	..	x	..	.....
Wilson Warbler	..	..	..	x	..	.....
Canadian Warbler	1	5	29	..	..	.....
Redstart	7	23	16	..	..	.....
Pipit	3	47	4	..	few	.....
Mockingbird	..	..	..	x	..	.....
Catbird	5	30	10	..	..	.....

Species of birds	Number of stomachs examined	Average number of locusts	Average number of other insects	Seen eating locusts	Average number of seeds and grains	Other food
Brown Thrasher	..	..	..	x	..	.....
Rock Wren	..	..	..	x	..	.....
Carolina Wren	..	..	..	x	..	.....
Bewick Wren	..	..	..	x	..	.....
House Wren	..	..	..	x	..	.....
Western House Wren	..	..	..	x	..	.....
Winter Wren	1	13	..	..	..	.....
Long-billed Marsh Wren	..	..	..	x	..	.....
Brown Creeper	..	..	..	x	..	.....
Slender-billed Nuthatch	4	23	4	..	4	.....
Red-breasted Nuthatch	..	..	..	x	..	.....
Tufted Titmouse	4	65	4	..	few	.....
Plain Titmouse	..	..	..	x	..	.....
Long-tailed Chickadee	9	53	6	..	..	.....
Golden-crowned Kinglet	..	..	..	x	..	.....
Ruby-crowned Kinglet	1	29	x	..	..	.....
Blue-gray Gnatcatcher	..	..	..	x	..	.....
Townsend Solitaire	..	..	..	x	..	.....
Wood Thrush	3	22	4	..	..	.....
Wilson's Thrush	2	36	29	..	..	.....
Olive-backed Thrush	2	27	12	..	..	.....
Hermit Thrush	1	19	16	..	..	.....
Robin	6	45	14	..	2	.....
Bluebird	3	22	6	..	..	.....
Mountain Bluebird	..	..	..	x	..	.....

The examination of the contents of bird stomachs reveals the fact that even insects that are commonly supposed to be "protected" from enemies by concealing coloration, noxious secretions, defensive armor, hairy coats and other means, are eaten regularly by many species of birds, sometimes in large number.[35] Leaf beetles, supposed to be "disagreeable" to birds, have been found in many Meadowlark stomachs and constitute 3 per cent of the food of the Baltimore Oriole for the year—8 per cent for July and 5 per cent for August.[36] The "nauseous secretions" of fireflies do not protect them from birds, as they furnished 2.71 per cent of the food in 28 stomachs of the Rose-breasted Grosbeak and 2.38 per cent of the food in 52 Black-headed Grosbeak stomachs.[37] It is fortunate that more birds do not feed upon the fireflies, as the latter feed largely upon injurious insects and are conse-

[35] McAtee, *Proc. Acad. Nat. Sci. Phila.*, LXIV, 281-364, 1912; *Auk*, XL, 560, 1923. Beal, *Yearbook U. S. Dept. Agric. for* 1908, 346-347.
[36] Beal, *Yearbook U. S. Dept. Agric. for* 1896, 423, 428.
[37] McAtee, *U. S. Biol. Surv., Bull.* 32, 44, 68, 1908.

quently considered useful. Tree hoppers, usually considered highly protectively adapted, have been found in the stomachs of 120 species of birds, in some instances in large numbers.[38] Beetles with offensive odors are taken by 13 species of birds, according to Hyslop,[39] and beetles having irritating and blister-forming secretions are taken by various species of birds, according to Judd and Beal.[40] The Io moth, protected by sharp, poisonous tubercles, has been found in the stomachs of five Cuckoos.[41] These are only a few examples out of many reported. Furthermore, some species that do not ordinarily take adult insects, especially ants, feed extensively upon their eggs and larvæ,[42] which are not so easily recognized in examining the contents of stomachs and consequently often escape detection.

Even in winter, birds obtain a great many insects. It is not surprising that Chickadees, Nuthatches and other birds that search the rough bark of trees find many insects at all seasons of the year, or that Woodpeckers obtain insect larvæ by drilling into the wood in winter as well as in summer; but insects are not infrequently found in the stomachs of even ground-feeding birds in winter. A winter stomach of a Meadowlark in Ontario was found to be full of insects,[43] and 47 per cent of the contents of 6 stomachs of the same species taken in the United States while snow was on the ground consisted of insects.[44]

Sullivan says that the great slaughter of wild birds and the destruction of from 80,000,000 to 100,000,000 of their eggs annually in France for some time resulted in the poor crops of 1861 because of the increase of insects, and that the summer following a great bird drive near Bridgewater, Massachusetts,

[38] McAtee, *Auk*, XXXV, 374. 1918.
[39] Hyslop, *U. S. Bureau of Entom., Bull.* 95, part V.
[40] Judd, *U. S. Biol. Surv., Bull.* 17, 101, 1902. Beal, *U. S. Biol. Surv., Bull.* 44, 12, 1912; Yearbook *U. S. Dept. Agric. for* 1896, 428.
[41] Beal, *U. S. Biol. Surv., Bull.* 9, 9, 1898.
[42] *Science Gossip*, Dec., 1885, 281.
[43] Nash, *Birds of Ontario*, 16.
[44] Beal, *Yearbook U. S. Dept. Agric. for* 1896, 421.

the trees in the neighborhood were defoliated by insects.[45] He adds that "the greatest losses from the ravages of the Rocky Mountain locust were coincident with the appalling destruction of millions of Blackbirds, Prairie Chickens, Quail, Plover, Curlew and various other birds." Trotter (quoting Kalm) declares that bounties upon Blackbirds (or "Maise Thieves," as they were called) caused the slaughter of so many of the birds as to produce a plague of "corn-worms," upon which the birds feed, in 1749, which led to a marked change in public sentiment in favor of the birds,[46] according to Benjamin Franklin.

The accumulation of information concerning the food habits of birds has made it possible to utilize them in special ways in getting rid of local pests. Mallard Ducks have been successfully introduced into ponds and swamps in Pennsylvania to rid the water of mosquito larvæ, where it was impracticable to drain the basins, and they proved much more effective than fishes introduced for the same purpose.[47] Various species of wild birds have also been introduced by market gardeners into their glass-enclosed structures to combat the insects that infest lettuce and other vegetables, and in Utah the farmers have introduced California Quail to fight the destructive imported alfalfa weevil, with great success.[48]

It has been asserted that in order for a bird to be useful in the control of insects it must kill 30 times as many harmful insects as useful.[49] This, however, has been strongly and apparently conclusively combated by several of the greatest authorities on the subject.[50] The same objection would apply also to the use of sprays and fumigants, which kill the useful

[45] Sullivan, Extension Dept. Kansas State Agric. Coll., *Agricultural Education*, III, No. 7, 12-13.
[46] Trotter, *Auk*, XX, 256-1903.
[47] Dixon, *Journ. Amer. Medical Assn.*, LXIII, 1203, 1914.
[48] McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 434-435.
[49] Welch, "Birds and Insects," *Practical Entomologist*, II, 44-47.
[50] Consult: Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, 11-12, 90-93, 157-159. Judd, *U. S. Biol. Surv., Bull.* 17, 36-40, 1902. Beal, *U. S. Biol. Surv., Bull.* 30, 28, 1907; *Yearbook U. S. Dept. Agric. for* 1908. 346, 349.

with the harmful insects. Furthermore, the useful parasitic insects do not at once kill the harmful insects they attack, but leave them to continue their damage for a time after the parasitic eggs are deposited, while the birds kill their prey outright and at once stop any further damage by the insects they attack. It must also be remembered that even a useful species of insect would be a great nuisance in a short time if unchecked by its enemies. Also, if the birds destroy an equal proportionate number of harmful and useful insects, their ratio to each other would remain just the same. Finally, if the birds ordinarily devour both harmful and useful insects indiscriminately, when the harmful ones become overabundant the birds turn their attention to the abundant kinds and aid in checking them, as is well known to all ornithologists.

XII

BIRDS AS ENEMIES OF INJURIOUS MAMMALS

With the exception of insects, rodents are probably the most destructive animals. As with birds, their rate of reproduction is high. Field mice have from 6 to 13 young at a time and from 2 to 6 litters per annum.[1] Rabbits also increase very rapidly under favorable circumstances, as do some species of ground squirrels and other small mammals. There is no doubt that, but for birds that prey upon them, mice, rats, squirrels, prairie-dogs and rabbits would swarm over the land and destroy most vegetation, thus rendering agriculture hopeless, unless we could find some equally effective way to combat them. The indiscriminate slaughter of birds of prey has often been followed by ravages of voles and other rodents, while frequently, on the other hand, unusual abundance of mice or rabbits in certain localities has attracted large numbers of predatory birds to feed upon them, including Hawks, Owls, Gulls, Ibises, Storks, Spoonbills, Cranes, Herons, Ravens, Crows, Magpies, Jays and others, which "should be sufficient to demonstrate the utility of these birds as a check upon the undue increase of such pests" under normal conditions.[2]

During the outbreak of mice in Nevada from 1906 to 1908 many fields were destroyed. After the breeding season, when various species of the larger birds ceased feeding upon insects

[1] Piper, "The Nevada Mouse Plague of 1907-8," *U. S. Dept. Agric., Farmers' Bull.* 352, 1909; "Mouse Plagues: Their Control and Prevention," *Yearbook U. S. Dept. Agric. for* 1908, 303.

[2] Beal, "How Birds Affect the Orchard," *Yearbook U. S. Dept. Agric. for* 1900, 300. Fisher, "Hawks and Owls from the Standpoint of the Farmer," *Yearbook U. S. Dept. Agric. for* 1894, 219, 224-225 (revised and published as *U. S. Biol. Surv. Circular* 61, 1907). Lantz, "An Economic Study of Field Mice," *U. S. Biol. Surv., Bull.* 31, 42-43, 47-48, 52-53. Piper, *Yearbook for* 1908, 303-309.

and turned to rodents, they soon greatly depleted the number of mice.[3] According to Lantz, complaints of depredations of field mice "are especially numerous from sections of the United States where for several years bounties have been paid for killing Crows."[4] During the vole outbreak in Scotland in 1892, following war upon predacious birds by gamekeepers, several species of Gulls fed largely upon these pests,[5] and Gulls are usually listed among the birds that follow the migrations of lemmings and feed upon them. In 1872-1873 a great plague of deer-mice occurred in South America. In May, 1873, according to Hudson, Storks and Short-eared Owls, both usually scarce in the region of the plague, appeared in "countless numbers" to feed upon the mice.[6]

Bailey definitely lists 9 species of Hawks and 6 species of Owls as enemies of prairie ground squirrels,[7] and 2 species of Hawks and 3 species of Owls as enemies of pocket gophers.[8] Piper, in discussing the bird enemies of the pocket gophers, mentions the Barn Owl as especially valuable.[9] Fisher lists 17 species of Hawks and Owls as enemies of the rabbits,[10] while Palmer lists 8 species as enemies of the jackrabbits.[11] Lantz mentioned 7 species of Hawks and 4 of Owls as enemies of the brown rat.[12]

Warren reports that two Screech Owls placed in a cellar overrun by mice cleaned them out in a few weeks.[13] Cats

[3] Piper, *Farmers' Bull.* 352. See also Piper, *Yearbook for* 1908, 301-310. Bailey, *Farmers' Bull.* 335, 1908.
[4] Lantz, *U. S. Biol. Surv., Bull.* 31, 51, 1907; "Meadow Mice in Relation to Agriculture and Horticulture," *Yearbook U. S. Dept. Agric. for* 1905, 363-376.
[5] Lantz, *U. S. Biol. Surv., Bull.* 31, 53. Fisher, *Yearbook for* 1894, 219, 224-225.
[6] Hudson, *Naturalist in LaPlata*, 64-65, 1892; quoted by Lantz, *U. S. Biol. Surv., Bull.* 31, 52-53.
[7] Bailey, *U. S. Div. Orn. and Mamm., Bull.* 4, 1893.
[8] Bailey, *U. S. Div. Orn. and Mamm., Bull.* 5, 1894.
[9] Lantz, "Gophers as Enemies of Trees," *Yearbook U. S. Dept. Agric. for* 1909, 209-218.
[10] Fisher, "The Rabbit as a Farm and Orchard Pest," *Yearbook U. S. Dept. Agric. for* 1907, 329-342.
[11] Palmer, *U. S. Div. Orn. and Mamm., Bull.* 8, 1896.
[12] Lantz, "The Brown Rat in the United States," *U. S. Biol. Surv., Bull.* 33, 1909.
[13] Warren, *Birds of Pennsylvania*, 154, 1890.

placed in a rat-infested storage cellar of a brewery rushed out when the doors were opened in the morning, showing every indication of fear, and fought against being taken back. An Owl was placed in the cellar and next morning 9 headless rats were found. Each morning for three weeks dead rats, partly devoured, were found, until the rodents became so scarce that the Owl had to be fed raw meat to prevent starvation.[14]

[14] McAtee, *Ann. Rept. Smithsonian Institution for* 1920, 433.

XIII

BIRDS AS ENEMIES OF INJURIOUS PLANTS

It is now well known that many birds do not digest certain kinds of seeds taken with their food, but pass them through the digestive tract or regurgitate them uninjured.[1] They digest only the outer coating, not only in case of fruits with pulp such as cherries, raspberries and strawberries, but also in case of many other seeds. Taylor reports that a great many seeds which have passed through the alimentary canals of English Sparrows, Greenfinches and Bullfinches have been tested and found to germinate, showing no injury.[2] He quotes Collinge as saying: "The expense of cultivation to eliminate weeds is, I believe, not reduced in the slightest by the action of birds." That is, however, an extreme view, not justified by the facts. A great many seeds do not pass through uninjured, some are uninjured by certain species of birds and destroyed by others, and many of the unimpaired seeds passed or regurgitated are those of plants that do no harm. Furthermore, as Forbes has stated, there are some kinds of very important crops that cannot be kept free from weeds by hoeing or any of the ordinary methods of cultivation, but the weeds may be kept down by encouraging the winter birds and others that live chiefly upon weed seeds and destroy the seeds in so doing.[3]

First we may notice some instances in which the seeds are not injured. Robins are known to pass or disgorge seeds of the cherries, dogwood, pepper, hackberry, raspberries, strawberries and others, but they are not considered particularly

[1] Beal, *U. S. Dept. Agric., Bull.* 171, 13, 1915.
[2] Taylor, *Proc. Entom. Soc. Brit. Col.*, July, 1913, 38.
[3] Forbes, *Two Years with the Birds on a Farm*, 12-14, 1908.

harmful and their dissemination by birds is a matter of small importance.[4] Rows of cedars sometimes line the hedge-rows, springing up from seeds dropped by birds, including Robins, Cedar Birds, and many others.[5] Townsend's Solitaires and Varied Thrushes all eat pepper berries, digest the small amount of nutriment in the viscid coat and disgorge the seeds. Bohemian Waxwings,[6] various species of Thrushes, Vireos and some other birds regurgitate the seeds of cherries and other large seeds.[7] Many seeds pass through the digestive tract of the Pigeon and are ground up and destroyed, while others are regurgitated.[8]

On the other hand, the majority of seed-eating birds crack the weed seeds or grind them and thus destroy large quantities of highly injurious kinds, doing much good in that way. In a patch of smartweed a space 18 inches square was carefully examined and 1,130 cracked seeds were found, with only two whole seeds. In late May practically no seeds were left in the patch.[9] It has been estimated by the U. S. Biological Survey that the various species of Sparrows alone saved the farmers $89,260,000 in 1910 by the destruction of weed seeds.[10] "A single plant of one of these species may mature as many as one hundred thousand seeds in a season, and if unchecked would produce in the spring of the third year ten billion plants."[11] Sparrows and Juncoes so thoroughly cleaned out the seeds from a big tangle of smartweed on a Maryland farm that none of the weeds appeared during the following year.[12]

The Finch family, the largest family of birds, including Sparrows of many species, Grosbeaks, Crossbills, and their

[4] Beal, *U. S. Dept. Agric., Bull.* 171, 13, 1915.
[5] Judd, "Birds of a Maryland Farm," *U. S. Biol. Surv., Bull.* 17, 62-65, 1902.
[6] Grinnell, *Auk*, XIV, 318-319, 1897.
[7] Bergtold, *Auk*, XXXIV, 342, 1917. Proctor, *Auk*, XIV, 412, 1897.
[8] Sayle, *Auk*, XLI, 474-475, 1924.
[9] Judd, "Birds as Weed Destroyers," *Yearbook U. S. Dept. Agric. for* 1898, 220; *U. S. Biol. Surv., Bull.* 15, 28.
[10] *U. S. Dept. Agric., Bull.* 513, 4, 1913.
[11] Judd, *Yearbook U. S. Dept. Agric. for* 1898, 221.
[12] Judd, *U. S. Biol. Surv., Bull.* 15, 27-28, 1901. McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 433.

allies, are preëminently seed-eaters, having bills especially adapted to the cracking of the seeds of various weeds. This is well exemplified in the Canary. An examination of 4,000 stomachs of native North American Finches and Sparrows of various species showed that during the colder half of the year their food consists almost entirely of weed seeds.[13] In a garden, in two months they may destroy 90 per cent of the seeds of such weeds as pigeon grass and ragweed.[14] Many birds besides the Finch family indulge largely in seed eating. Judd found that weed seeds constituted 18 per cent of the total food of all birds collected on a Maryland farm, and that the seeds were taken by 20 of the species on the farm.[15] The crops of Bob-whites are often gorged with ragweed seeds.[16] The Blue Grosbeak is said to be an enemy of Johnson grass, a very obnoxious plant.[17] The Tree Sparrow alone in one state is said to consume annually 875 tons of seeds of obnoxious weeds.[18]

Poison ivy and poison oak seeds are taken by a great many species of birds, particularly including the following: [19]

Woodpeckers	Bluebirds	Vireos
Warblers	Mockingbirds	Thrashers
Cactus Wrens	Tits	Kinglets
Thrushes	Towhees	Sparrows
Grosbeaks		

Perhaps this item, however, must be placed on the debit side of the ledger, in most cases, as a considerable part of the seeds are not destroyed, but are regurgitated or evacuated uninjured, and thus this troublesome plant is disseminated by the birds.

[13] Judd, "Birds as Weed Destroyers," *Yearbook U. S. Dept. Agric. for* 1898, 223.
[14] Judd, "The Relation of Sparrows to Agriculture," *U. S. Biol. Surv., Bull.* 15, 29, 1901.
[15] Judd, "Birds of a Maryland Farm," *U. S. Biol. Surv., Bull.* 17, 70-71, 1902.
[16] Judd, *Yearbook for* 1898, 231.
[17] Dixon, *Condor*, XVII, 204, 1915.
[18] Beal, *U. S. Dept. Agric., Farmers' Bull.* 54, 28, 1898.
[19] *Ibid., Bull.* 54, 34, 1898; *U. S. Div. Orn. and Mamm., Bull.* 7, 9, 1895. Judd, *U. S. Biol. Surv., Bull.* 17, 62, 1902.

Edson [20] has published a long list of seeds and fruits eaten by birds in a park at Rochester, New York. Judd has a list of weed seeds eaten by birds in a very illuminating discussion of this subject, based upon a thorough investigation of the food of birds on a Maryland farm.[21] In view of all the evidence that has been published it is astonishing that anyone should doubt the value of birds as enemies of weeds.

Certain species of birds feed to some extent upon buds and perhaps occasionally, when they gather in large numbers, may do considerable damage, but not usually.[22] Buds are generally more abundant than need be, and the partial budding of the trees and shrubbery is ordinarily more useful than harmful.

[20] Edson, *Bird-Lore*, XVII, 448-449, 1915.
[21] Judd, *U. S. Biol. Surv., Bull.* 17, 70-78, 1902.
[22] Beal, *U. S. Biol. Surv., Bull*, 34, 75, 1910.

XIV

BIRDS AS SCAVENGERS

It has long been recognized by ornithologists, and to some extent, at least locally, by farmers and citizens generally, that some species of birds are engaged in the useful occupation of scavengers, disposing of the garbage and carrion of the fields, which would otherwise taint the atmosphere with disagreeable, if not unhealthful, odors. During the early history of the Great Plains of Western North America, Turkey Vultures, or Buzzards, as they are popularly called, could have been seen at almost any hour of the day circling over the prairies in search of food. When a bison or other animal died or was killed, these big black birds soon gathered about the carcass and began the task of disposing of its flesh. With the assistance of Crows, Magpies, coyotes and other birds and mammals, they kept the plains and mountains comparatively free from putrifying carrion. With the settlement of the region the Vultures have become rare over a great portion of their former range, owing chiefly to the poisoning of carcasses in the effort to destroy coyotes. The great California Condor, less prolific and never so abundant, has become even more rare, partly from the same cause and partly because its eggs have been so eagerly sought by collectors.

Various other groups feed extensively upon carrion, especially the Gulls. They were among the first non-game birds to come under protection of law, particularly about large harbors, where their value as scavengers has long been recognized. Few more impressive object lessons in economic ornithology have been witnessed than the large flocks of gulls following the city garbage scows as they were being towed out to sea,

feeding voraciously upon the waste from the kitchens. The Gulls long since learned that much food is thrown from boats. So they may be seen following in the wakes of vessels, sometimes far from land, watching for the morsels that drop into the water. So general is their presence that a painting of a ship hardly seems complete without Gulls hovering near, though the artist may have no idea of the reason for their presence. In the harbors there is scarcely a chance for a bit of refuse to escape their sharp eyes. They patrol the beaches and dispose of the dead fishes and other marine life washed ashore by the waves or left stranded by the tides. Yet these beautiful and useful birds have been at times much persecuted and hundreds of thousands of their skins and wings have gone to the market as ornaments for the hats of the gentler sex—the sex one would expect to be first in the demand for the protection of birds.

"Some birds, notably Eagles, Crows and Buzzards, feed at times largely upon dead fish," [1] schools of which are sometimes thrown up on the beach by storms and create an almost unbearable stench unless birds gather in force to dispose of them.

Crows, Ravens, Magpies and other birds search the fields and pastures for food, and do not disdain a dead mouse or the carcass of a squirrel or rabbit struck down by storm or accident. Thus they prevent much carrion from tainting the atmosphere, providing breeding places for certain troublesome insects and otherwise creating unsanitary conditions to the discomfort and detriment of the human race.

[1] Judd, *U. S. Biol. Surv., Bull.* 17, 53-54, 1902.

XV

BIRDS AS CARRIERS OF DISEASES AND PARASITES [1]

Crows, Vultures, Magpies and other birds that feed upon carcasses of diseased animals have been accused, with some reason, of spreading diseases of domestic live stock and poultry, "but the fact that there are many other carriers which lie largely beyond our control shows that we must seek relief only through the strictest methods of sanitation," [2] not by the destruction of a few birds rightly or wrongly suspected of being carriers. Various birds, including Pigeons, have been accused of disseminating hog cholera, but very careful experiments [3] with Pigeons thoroughly discredit their connection with the spread of the disease and throw grave doubt upon the likelihood that any other birds except possibly carrion feeders are in any way responsible for it. Turkey Vultures ("Buzzards") and their relatives, the Black Vultures, have been persecuted in some regions, especially the South, as carriers of hog cholera, black-leg and anthrax, but experiments prove that these birds have very little to do with the spread of the diseases, while but little effort has usually been made to combat flies and other creatures that are largely responsible for causing epidemics among domestic animals.[4]

During the recent epidemic of the dreaded foot-and-mouth disease in California, the relation of birds to the carrying of

[1] As to distribution of seeds of obnoxious plants, see chapter on "Birds as Enemies of Injurious Plants."

[2] Beal, *U. S. Dept. Agric., Bull.* 630, 18, 1914.

[3] McAtee, *Auk*, XXXV, 253-254, 1918, quoting *Ann. Rept. Chief of U. S. Bureau of Animal Industry for* 1917, 48.

[4] McAtee, *Auk*, XXX, 295-298, 1913, quoting Darling and Bates, *Amer. Vet. Rev.*, XLII, No. 1, pp. 70-75, 1912, and Morris, *La. Exper. Sta., Bull.* 136, 1912.

the infection from place to place was much discussed but not adequately investigated. Manifestly it is quite possible that birds that feed upon carrion, or birds whose habit is to pick up waste grain from the feeding pens of infected cattle, have been instrumental in the spread of the disease in some instances. However, investigation by the United States Biological Survey and others in the "heart of the infected district yielded no positive evidence that wild birds distribute the disease," while in the more general outbreak of the disease in 1914, affecting 22 states, birds were suspected of being the carriers in only 17 out of 3556 infected herds.[5] Stockman and Barnett[6] thought they detected a remarkable relation between bird migration and epidemics of the sort, but subsequent analysis of their data in detail by Thomson[7] does not support that conclusion. Until more thorough investigation results in some definite knowledge of the means of distribution of the disease, opinion should be reserved and birds not destroyed on mere suspicion. Various other carriers are at least as likely as birds.

In connection with the carrying of disease we may also consider the dissemination of external parasites, with which birds are often charged. Ewing's[8] investigations demonstrate that the English Sparrow harbors and distributes the chicken louse or mite (*Dermanyssus gallinæ* Redf.), one of the worst poultry pests, as well as the bird mite (*D. avium* DeGeer), one of the most troublesome external parasites of cage birds, such as the Canary. Domestic Doves have also been accused of the same thing, with some reason, though perhaps it has not yet been definitely proved. The charge that Swallows and other birds distribute external parasites (lice, etc.) that

[5] McAtee, "Birds in Relation to the Foot-and-Mouth Disease of Cattle," *Auk*, XLI, 628-629, 1924.

[6] Stockman and Barnett, "Bird Migration and the Introduction of the Foot-and-Mouth Disease," *Journ. Ministry of Agric.* (London), XXX, 681-695, 1923.

[7] Thomson, "Bird Migration in Relation to the Foot-and-Mouth Disease," *Nature*, CXIII, 52-54, 1924.

[8] Ewing, "The English Sparrow as an Agent in the Dissemination of Chicken and Bird Mites," *Auk*, XXVIII, 335-340, 1911.

infest human beings is not supported by the evidence. Bird parasites cannot live on human beings and the reverse is also true. "It is firmly established that man's [external] parasites are not borne by our avian friends." [9]

It has been said that birds are guilty of distributing the chestnut-blight fungus, but it has been conclusively shown that the ascospores of the fungus are carried in great quantities by the wind, and that the work of birds in the dissemination of the plant is negligible,[10] though there seems to be no doubt that they actually do carry some of the ascospores.[11] In California a Titmouse [12] was found to be covered with what appeared to be pollen of slime molds, which are mostly considered harmless, but the incident, with others, show that it is not impossible for birds to sometimes do more or less harm as pollen carriers, for if they carry pollen of harmless species they may also carry that of harmful kinds.

[9] Wetmore, *U. S. Dept. Agric., Bull.* 326, 87, 1916.
[10] McAtee, *Auk*, XXXIII, 378, 1915.
[11] Heald and Studhalter, "Preliminary Note on Birds as Carriers of the Chestnut Blight Fungus," *Science*, XXXVIII, 278-280, 1913, citing a number of other publications.
[12] Grinnell, *Auk*, XXXVIII, 129-131, 1921.

XVI

THE DESTRUCTION OF BIRDS AND ITS CAUSES

It having been demonstrated to the satisfaction of naturalists that the great majority of all wild birds are useful, some of them vitally so, to man, the need of protective legislation and a healthy public sentiment in favor of their preservation is quite apparent from the consideration of the facts. During all except the last two decades of the past century the destruction of birds was going on in the United States and elsewhere at an appalling rate. During the last two or three decades the destruction has been to a considerable extent checked in most parts of the United States, owing to legislation, and more particularly, perhaps, to the educational work carried on by various agricultural, horticultural and ornithological societies and in the public schools, and the widespread distribution of literature on the subject by the United States Department of Agriculture and the National Association of Audubon Societies. Notwithstanding this, there is still an astonishing amount of ignorance upon this subject on the part of otherwise well-informed people.

Over a quarter of a century ago the New York Zoölogical Society, in coöperation with ornithologists throughout the United States, conducted an investigation of the decrease in the number of birds. The report[1] showed an average decrease of 46 per cent in 30 states, an increase in 4 and increase and decrease balanced in 3. As the eggs of birds aver-

[1] Hornaday, "Destruction of Our Birds and Mammals: A Report on the Results of an Inquiry," *Ann. Rept. N. Y. Zool. Soc. for* 1898; republished, with addenda, in 1901; *Our Vanishing Wild Life*, 1913. Oldys, *Yearbook U. S. Dept. Agric. for* 1902, 206-209.

age probably not more than four to the clutch and not more than half of them ever develop birds to maturity, such destruction cannot be readily replaced. A large amount of information concerning destruction of birds and methods of prevention may be found scattered through the pages of books on game birds by Forbush and Grinnell, Bryant and Storer.[2]

Normal Natural Destruction

There is a very great normal annual destruction of birds from various causes, which need occasion no alarm unless supplemented by large loss from other sources, as it is taken care of by the normal rate of reproduction; but birds have enough natural enemies, without adding any unnecessary agencies of destruction. Under ordinary natural conditions numerous enemies keep the birds in check, so that they do not increase inordinately, as we have seen in another chapter. Snakes and squirrels climb the trees and devour the eggs and young. Minks, rats, weasels, foxes and many other small predacious mammals take many birds, especially ground-nesting species. During the nesting season almost every severe local storm wrecks many nests and destroys the eggs and nestlings. Even the loss caused by widespread storms is in most cases taken care of by the "factor of safety," overproduction. These losses are natural. If they were not cared for by the rate of reproduction, the birds would long ago have been exterminated.[3] On the other hand, if the rate of reproduction exceeded the natural losses, birds would long ago have overpopulated the surface of the earth. When to the natural perils is added enormous loss from unnatural causes, due to advancing civilization—the intervention of man—they cannot indefinitely withstand the combined assault upon their ranks.

[2] Forbush, *Game Birds, Wild-Fowl and Shore Birds*, 1912; see especially pp. 399-595. Grinnell, Bryant and Storer, *Game Birds of California*, 1918; see especially pp. 6-60.

[3] Grinnell, *Science*, n. s., LVI, 671-676, 1922.

It is estimated that in a single storm on the coast of the state of Washington 50,000 young water birds lost their lives.[4] After a storm in May dead birds of 26 species were found in a two-mile stretch of the Lake Michigan shore, and at Racine 645 dead birds of 22 species were found, mostly Warblers.[5] After a thunder shower on Long Island 30 dead Robins were found on an acre of ground.[6] Following a severe hailstorm at a large Great Blue Heron colony near Lyons, Colorado, in 1907, great numbers of the birds were found dead among the trees, and the notebooks of Denis Gale indicate that many nests in the same colony were ruined by a windstorm in 1890.[7] After another hailstorm at Boulder, Colorado, 7 or 8 Goldfinches were found dead on a single lot.[8] Several times there has been great destruction of Bluebirds in the Middle West by late snowstorms.[9] It is estimated that severe winter weather of 1903-4 reduced the Bob-white in New England by 95 per cent, and many other birds by smaller percentages.[10] After a storm in March, 1904, a careful survey of a small district in Southwestern Minnesota resulted in a calculation that a million and a half Lapland Longspurs had perished.[11] After a cyclone in South Carolina dead Shearwaters were found on the beach in "countless numbers," with a "great many" dead Pelicans.[12]

It is stated that in one stormy spring month in 1907, in Wisconsin, Iowa, Michigan and Minnesota, "millions of birds lost their lives" because of bad weather during migration.[13] The perils of migration are numerous, not the least of which are disastrous storms that catch "waves" of migrating birds as they cross large bodies of water, such as the Great

[4] Reagan, *Auk*, XXVII, 92, 1910.
[5] Deane, *Auk*, XXXI, 548-549, 1914.
[6] Childs, *Auk*, XXX, 590, 1913.
[7] Henderson, *Condor*, IX, 162, 1907.
[8] Henderson, *Wilson Bull.*, XX, 213-214, 1908.
[9] Widmann, *Bird-Lore*, VIII, 171, 1906.
[10] Forbush, *Auk*, XXII, 25-31, 1905.
[11] Roberts, *Auk*, XXIV, 369-377, 1907.
[12] Wayne, *Auk*, XI, 85, 1894.
[13] Sherman, *Bird-Lore*, XVII, 376, 1916.

Lakes and the Gulf of Mexico.[14] This is not so serious with water birds, but for land birds in flight over water wet plumage means a watery grave. It is estimated that during a storm on Lake Michigan half a million birds washed ashore, and doubtless only a small proportion of those that lost their lives were washed in. After a snowstorm on Lake Huron in 1906 thousands of dead birds of many species were found on the shore.[15] Hundreds of such instances as the foregoing are related in the scattered periodical literature of ornithology, and doubtless the great majority never get into print.

Destruction is caused not only by storms of wind, hail, snow and rain, but by other weather conditions. In 1912 many water birds perished on Lake Cayuga, New York, from the freezing of the water, which shut off their food supply.[16] The loss was especially heavy in case of Grebes and other birds that can only take wing from open water, as it prevented them from flying elsewhere in search of food. In Missouri a few years ago lightning killed an entire flock of 56 wild Ducks on the wing.[17]

Besides these larger disasters, there is a great annual loss of bird life through minor accidents of many kinds. Birds are frequently found tangled in strings used in nest building, or caught in crevices of various sorts, just as Canaries get their feet caught in the cage wires. One writer found in a single season within a radius of two miles from his post-office, 13 nests belonging to about 30 species ruined or the eggs or nests destroyed in various ways, though chiefly by a late snowstorm.[18] A recent study of 138 nests belonging to 13 species showed that casualties resulting from destruction or abandonment of the nest from various causes reached 59 per cent, only 76 young birds leaving the nests alive.[19] In

[14] Chapman, *The Travels of Birds*, 115-131, 1916. Coward, *The Migration of Birds*, 104-113, 1912.
[15] Saunders, *Auk*, XXIV, 108-110, 1907.
[16] Cahn, *Auk*, XXIX, 437-444, 1912.
[17] Widmann, *Wilson Bull.*, No. 69, Vol. XVI, new series, 225, 1909.
[18] Ingersoll, *Condor*, XV, 81-86, 1913.
[19] Clabaugh, *Condor*, XXVII, 114-115, 1925; XXVIII, 128, 1926.

Yellowstone Park many birds are known to have lost their lives by entering hollows in the bottoms of which heavy, poisonous gases have accumulated. In 1902 birds of 16 species were found dead in such places.[20] As such conditions have existed there for many hundreds of years, the total loss of life from that source must have been quite considerable. Another strange death trap for birds is the "Niagara Swan Trap," as it has been called. Sometimes large flocks of Swans alight upon the swift water of the river above the falls and are unable to take wing in time to avoid being carried down over the falls and many of them killed, though doubtless the majority of them survive the shock. Among the notable occurrences of the sort are those of 1908 and 1912, though they were also noted in 1909, 1910 and 1911.[21] This trap has been in operation for thousands of years and the aggregate toll it has taken must be large. It is interesting to know that it was observed in operation as early as 1750, as shown by a letter published in a book dated 1751.[22]

The foregoing are but a few among the many kinds of casualties that serve to keep birds in check under natural conditions, unaffected by the presence of man. Disease also claims its share of bird victims, though the investigation of this subject has as yet been desultory, covering only a few species of game birds and seldom thorough even as to the few, with practically no investigation of diseases of non-game birds. There is a very common belief that dead birds and mammals showing no marks of violent death are never found —that they never die from other than violent causes. Quite the contrary is true.

Gallinaceous birds, including Grouse, Pheasants, Quail, Turkeys and domestic fowl, are especially subject to epidemic diseases. Morse in discussing a "highly contagious and rapidly fatal disease" that appeared among the Quail of the

[20] Mearns, *Condor*, V, 36-38, 1903.
[21] Fleming, *Auk*, XXV, 306-309, 1908; *Auk*, XXIX, 445-448, 1912.
[22] Cole, *Auk*, XXVI, 63-65, 1909, citing Bartram, 1751, and Spencer, 1907, and quoting from the letter.

United States about 20 years ago, briefly includes some comments on a disease of the Grouse in England and Scotland, which was noticed at least as far back as 1817. He has also considered the diseases of Pheasants and methods of prevention and treatment. Very recently Gross has discussed the diseases of the Ruffed Grouse. So serious are they that at a recent conference of the American Game Protective Association a special committee was appointed to investigate the subject.[23] Forbush and Grinnell, Bryant and Storer, have discussed diseases of birds in their books on game birds.[24]

A large number of Shore Birds of various species perished apparently from some unknown disease in Montana a few years ago.[24a] Serious epidemics have occurred among the wild Ducks about Great Salt Lake in Utah, and Tulare and Owens Lakes, California, in some instances also affecting Herons and other birds. This has been attributed to alkali poisoning, from the large quantities of alkali taken with their food during dry seasons. Within one mile along a slough 1500 dead Ducks were counted at one time.[25]

In 1908 a serious intestinal tapeworm epidemic occurred among the Shearwaters, Scoters, Auklets and Murres of the State of Washington. Each bird dissected contained hundreds of parasites, but no food.[26] Many other instances of serious bird diseases are known.

Destruction Due to the Intervention of Civilized Man

All of the foregoing may be considered normal losses which are replaced by normal reproduction; otherwise birds would

[23] Morse, "Quail Diseases in the United States," *U. S. Bureau of Animal Industry, Circular* 109, 1907; "Diseases of Pheasants," *U. S. Dept. Agric., Farmers' Bull.* 390, 35-40, 1910. Gross, "Diseases of the Ruffed Grouse," *Science*, new series, LXII, 55-57, 1925. Forbush, *Game Birds, Wild-fowl and Shore Birds*, 540-541, 1912.

[24] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 540-541, 1912. Grinnell, Bryant and Storer, *Game Birds of California*, 17, 18, 43, 46, 52, 1918.

[24a] Wetmore, *Auk*, XXXVII, 451, 1920.

[25] Wetmore, "Mortality among Waterfowl around Great Salt Lake, Utah," *U. S. Dept. Agric., Bull.* 217, 1915; "The Duck Sickness in Utah," *Bull.* 672, 1918. Clarke, *Condor*, XV, 214-226, 1913.

[26] Bowles, *Condor*, XI, 33-34, 1908.

long ago have become extinct, as such losses have been going on for ages. They are the result of incidents for which Nature, in the development of species and their interrelations, has provided. The intervention of civilized man has introduced many new factors and produced far-reaching changes in environment. Some of the losses seem inevitable, others may be remedied. Inasmuch as the losses and reproduction under natural conditions were just about balanced, it is obvious that with the introduction of enormous additional annual losses there is urgent need of the adoption of special measures of protection and encouragement to offset those additional losses.

We have destroyed forests and ploughed large areas of prairie sod, converting the places they once occupied into fields and orchards. We have drained swamps and ponds and brought water through canals to irrigate lands that were once arid. We have built cities, railways and lighthouses and strung thousands of miles of wire overhead, each of which claims its numerous avain victims each year. We have destroyed nesting sites and feeding grounds of many species and provided nesting sites and feeding ground of very different character for others, thus producing marked changes in faunas. As reproduction and food are both necessary to the existence of any species of bird, the destruction of proper nesting ground and food supplies means the local annihilation of the species. The total loss from such causes is large and certain, but not so easily visualized as some of the losses due to accidents resulting from human agencies.

Many thousands of birds are killed every year by flying into lighthouses at night during stormy weather, chiefly in migration.[27] In 8 years, from 1897 to 1905, 2,000 birds, representing 60 species, blinded by the light, are known to have lost their lives by flying against the statue of William Penn on the City Hall tower (the "Municipal Bird Trap," as it

[27] Bennett, *Bird-Lore*, XI, 110-113, 1909. Gardiner, *Bird-Lore*, XVIII, 374, 1916. Chapman, *The Travels of Birds*, 123-126, 1916. Coward, *The Migration of Birds*, 104-112, 1912. Many other references could be cited from the extensive and scattered literature of the subject.

has been called) in Philadelphia.[28] Arc lights were the cause of the death of 1,000 birds in one night at Grand Rapids, Michigan.[29] Telephone, telegraph and electric light and power wires take a heavy toll of bird life,[30] the birds being unable to see the wires while in swift flight, especially when the light is not good in early morning and late evening. Railway trains and automobiles are responsible for the death of many young birds, and some adults.

These losses seem an almost inevitable accompaniment of civilization. Perhaps also the poisoning of birds cannot well be avoided in many instances. Aughey reported that 30,000 birds were poisoned in one season in one county of Nebraska, but that was done deliberately because the farmers suspected them of damaging the corn crop.[31] Whether poisons and fumigants used in orchards in the fight against insects have killed as many birds as some people suppose is questionable,[32] but there is apparently no doubt that a considerable number perish from this cause.[33] Certainly poison set out for coyotes has destroyed many Vultures and other scavengers. In some places the death of numbers of Ducks has been attributed to lead poisoning by the shot obtained at the bottoms of ponds and lakes and swallowed by the birds with their food. Lead poisoning has been known for years among upland game birds in England, developing shortly after each hunting season.[34] This is an indirect result of hunting, which, within reasonable limits, is justifiable. It might not be out of place here to mention another peculiar cause of death of birds as an indirect result of hunting. Sportsmen have frequently fired at a bird and seen it at once drop dead, but have been unable to

[28] Mercer, *American Ornithology*, V, 53-54, 1905.
[29] *Proc. Amer. Assn. of Museums*, IV, 42-43, 1910.
[30] Emerson, *Condor*, VI, 37-38, 1904.
[31] Aughey, 1st Rept. *U. S. Entom. Comm.*, 343.
[32] *Bird-Lore*, XVI, 402, 1914.
[33] Howell, *Condor*, XVI, 54-55, 1914.
[34] Warburton, *Condor*, XIX, 141, 1917. Bowles, *Auk*, XXV, 312-313, 1908. Wetmore, "Lead Poisoning in Waterfowl," *U. S. Dept. Agric., Bull.* 793, 1919, citing, on p. 11, *The Field* (London), XLVII, 189, 267, 1876; LIX, 232, 1882.

find any marks of shot or other injury. According to Beebe,[35] in such instances death is caused by a few very tiny drops of blood in the brain, resulting from hemorrhage, due to fright. Perhaps many birds found dead without marks of violence, where no shot has been fired, have died of fright from other causes.

Overstocking the range by cattle in arid portions of the southwestern part of the United States has seriously affected some species of birds, especially the Masked Quail.[36]

Serious fires resulting from the activities of man, avoidable or otherwise, take a heavy toll of bird life. Annually thousands of birds lose their lives in the United States in forest and prairie fires.[37] Not infrequently similar losses of life occur during the burning of buildings. This was observed especially during a big fire in Philadelphia in 1906.[38]

These more or less unavoidable losses due to factors introduced by civilization, however, are insignificant in comparison with the wanton, deliberate, wasteful destruction from various activities of human beings, a few of the minor of which will be first mentioned before proceeding to the major activities.

Ornithologists have frequently been charged with too much destruction of bird life in obtaining skins for study purposes. The loss from this source, however, is wholly negligible, and is much more than offset by the good the collections have done in giving students a better idea of the structure and food habits of the birds. Perhaps more birds have been destroyed in a single hunting season than there are in all the bird collections of the world. Most ornithologists and oölogists are in thorough sympathy with the idea of bird protection, and only take such birds and eggs as they need in their studies. However, there are, or at least in the past have been, notable exceptions. The Norris collection is said to have contained

[35] Beebe, *The Bird*, 201-202, 1906.
[36] Judd, *U. S. Biol. Surv., Bull.* 21, 46-47, 1905.
[37] Richter, The Oologist, XLII, 124, 1925.
[38] Coward, *The Migration of Birds*, 112, 1912.

1,274 sets of eggs of 5 species,[39] for which there seems to be no adequate excuse.

The small boy with a cheap, but effective, gun is doubtless responsible for his fair share of damage to the birds. That is the fault of his education. Much more reprehensible is the grown man who wanders about with a gun and fires at every bird that crosses his path. Instead of displaying his skill and prowess, as he fondly believes, he only displays his ignorance or wilful disregard of the welfare of the human race and his lack of appreciation of the beauty of the birds.

There are at least three major causes of the destruction of birds by the human race, outweighing in importance all other causes, all within the control of men and women and all deserving more extended discussion.

The Market Hunter.—Every sportsman and naturalist is familiar with the decrease in the number of game birds, some of which have been completely exterminated during the past century and others are rapidly approaching extinction. The reason, or at least one important reason, is not difficult to find. No species can long withstand the drain upon its numbers to which some game bird species have been subjected.

The extermination of the Passenger Pigeon in the United States is a disgrace to civilization. A century ago these beautiful birds occurred in the Eastern United States in flocks of incredible size. In the literature of that early period are numerous descriptions of the migration of the pigeons in such numbers as to darken the sky and shut out the light of the sun. Now there is not, so far as is known to naturalists, a single individual of the species living. The offer of large rewards for information concerning any living specimens in a wild state in 1910, 1911 and 1912 failed to bring such information. The last known example died on September 1, 1914, in captivity, at the age of about 29 years.[40] The birds were killed at their "roosts," not by hundreds or thousands, but

[39] Hornaday, 2nd Ann. Rept. *N. Y. Zool. Soc.*, 88-91.
[40] Shufeldt, *Auk*, XXXII, 30, 1915.

by tons, for the market. Those who saw the great flocks boldly asserted that it would be impossible to exterminate them, yet a few years later they were gone, closely paralleling the history of the American bison, which, though not yet extinct, is virtually so. Audubon tells of seeing schooners at the New York wharfs loaded in bulk with the Pigeons, selling at 1 cent each, in 1805, and Roney estimated that in 1878 1,500,000 dead birds and 80,532 live ones were shipped from near Petosky, Michigan.[41] Many such statements have appeared in the periodical literature of the past century. No one who reads the numerous accounts of the ruthless slaughter need wonder what has become of the Passenger Pigeon, a species whose rate of reproduction was so low that it must have required more than two years for each pair to reproduce a pair under normal circumstances. Even a much more prolific species could not long survive such an onslaught.

It was announced several years ago that 9 species of American birds had been exterminated in 50 years and others were rapidly disappearing.[42] Among the game birds formerly abundant over a wide range but now scarce, rare, or extinct may be mentioned the Eskimo Curlew, Wood Duck, Woodcock, Black-bellied Plover, Golden Plover and Long-billed Dowitcher.[43] Ducks are greatly lessened in numbers almost everywhere, though laws now limiting the bag and prohibiting spring shooting will have a marked tendency to check the rate of decrease, if not to restore a portion of the loss. The Eider Duck, once abundant on the Atlantic Coast of North America, is now quite scarce.[44]

The wild Turkey, formerly abundant, has been exterminated over a large part of its former range, is said to be entirely

[41] Palmer, *Yearbook U. S. Dept. Agric.* for 1899, 269. Deane, *Auk*, XXVIII, 262, 1911. Hodge, *Auk*, XXVIII, 49-53, 1911; *Auk*, XXIX, 169-175, 1912.

[42] Hornaday, *Proc. Amer. Assn. Museums*, VI, 111; *Our Vanishing Wild Life*, 1913. Beal, *U. S. Biol. Surv., Bull.* 37, 62-63, 1911.

[43] McAtee, "Our Vanishing Shorebirds," *U. S. Biol. Surv., Circular* 79, 1911. Fisher, "Two Vanishing Game Girds: The Woodcock and the Wood Duck." *Yearbook U. S. Dept. Agric. for* 1901, 447-458.

[44] Townsend, *Auk*, XXXI, 14-21, 1914.

extinct in New England and is becoming scarce elsewhere.[45] It has been the practice in Northern New Mexico to kill them by wagon-loads when they congregate about the scattered springs in the autumn.[46] Prairie Chickens, once abundant on the Western prairies, have reached the vanishing point in many places and have been greatly reduced everywhere, by ruthless slaughter for the market. In 1864 one shipment of these birds weighed 20 tons and some dealers sold from 150,000 to 200,000 in six months.[47] The Heath Hen, a bird of the wooded districts of the Eastern United States, has been reduced to a very small remnant confined to Martha's Vineyard. In 1874 11,400 Prairie Chickens and 4,400 Quail were shipped from 3 Western townships,[48] while 9,000,000 Bob-whites were killed for the market in Alabama in one season.[49] One dealer in Washington sold 100,000 Bob-whites in 1902; in a single week 8,400 California Quail were killed at one spring in 1891, and at that time 100,000 of them were marketed in San Francisco annually.[50]

The Upland Plover, one of the most insectivorous species of shore birds, which, if unmolested, would doubtless have been a great aid in the warfare against the cotton-boll weevil, was slaughtered in Texas "by the wagon-load" for the market, and where it once swarmed it is now comparatively rare.[51]

In 1909 5,719,214 game birds were killed for the market in Louisiana, where birds from the North congregate in the winter, and in 1821 48,000 Golden Plovers were killed in one day at a lake near New Orleans.[52]

[45] Judd, "The Grouse and Wild Turkeys of the United States and Their Economic Value," *U. S. Biol. Surv., Bull.* 24, 48, 1905. Sherman, *Wilson Bull.*, XXV, 87-90, 1913.
[46] Bailey, *Auk*, XXI, 352, 1904.
[47] Forbush, *Mass. Agric. Dept., Bull.* 9, 66, 1915.
[48] Aughey, 1st Rept. *U. S. Entom. Comm.*, 345.
[49] Forbush, *Mass. Agric. Dept., Bull.* 9, 66, 1915.
[50] Judd, "The Bob-white and Other Quails of the United States in Their Economic Relations," *U. S. Biol. Surv., Bull.* 21, 16-18, 48-49, 1905.
[51] Bailey, *U. S. Biol. Surv., Bull.* 22, 15, 1905.
[52] Forbush, *Mass. Agric. Dept., Bull.* 9, 66, 1915.

With the almost innumerable accounts of which the foregoing are but a few samples, need one ask what has become of the game birds once so abundant in the United States? However, the depredations of the market hunters have not stopped with what are now generally considered game birds. It seems strange that Flickers, included among our very valuable insectivorous birds, were once sold as game in the open market. Robins were formerly sold in the American markets and not so very long ago at that. One dealer in Washington, D. C., sold 2,600 in one month, and 4,000 were killed in Pittsboro, South Carolina, at one time as late as the winter of 1911-1912.[53] Many of them have found their way into the market under the name "Rice Birds" and been eaten by people who were totally ignorant of the fact that they were eating Robins. The real Rice Birds, or Bobolinks, have been extensively sold for food. One million are said to have been killed for the market near Philadelphia in one month.[54]

Farmers' contests, not having for their object even the marketing of the birds, have destroyed their thousands, a good example of which occurred in Georgia in 1911, when 11,231 Meadowlarks were killed for prizes,[55] the excuse offered for this wanton act being that the birds are enemies of the corn. Ignorance on the part of legislators has also at times led to great destruction of useful birds through the operation of bounty acts, not only in case of such gregarious species as Blackbirds, but also in case of some of the most useful of the Hawks and Owls.

The House Cat.—One of the most disastrous activities of man in relation to bird life is the introduction of the domestic cat. The assertion that certain pet cats do not catch birds because of their good breeding and training is not borne out by investigation. Cats whose owners were positive they did not catch birds have in many cases been carefully watched

[53] Forbush, 4th Ann. Rept. *Mass. State Ornithologist*, 28, 1912. Hornaday, 2nd Ann. Rept. *N. Y. Zool. Soc.*, 85.
[54] Sullivan, *Economic Value of Bird Life*, 13-14, 1912.
[55] *Bird-Lore*, XIII, 123, 1911.

while young birds were leaving the nest and found to catch them one after another. In alleged proof of the fact that certain cats would not catch birds it has often been asserted that they watch Robins on the lawn and do not molest them, but careful observation of such cats has usually proved that they do catch the young birds as they leave the nests. The act is instinctive, handed down from parent to offspring for a thousand thousands of generations. Springing upon a fluttering young bird is an impulsive response to external stimuli—an instinct coming up out of the whole past history of the cat tribe, not a mere habit to be corrected by any amount of breeding and training.

The cat has been the subject of a large amount of careful investigation by naturalists for the purpose of determining just its economic status, resulting in the conviction that it does a great deal more damage in the destruction of birds than good in the destruction of mice and rats.[56] Cats destroy more birds than any other animal except man—1,500,000 annually in New England, according to Forbush, and 3,500,000 annually in New York, according to Fisher.[57] In Massachusetts 226 cats under observation killed 624 birds in one day,[58] even pet cats "taught from kittenhood not to kill birds" being caught in the act. On one Connecticut estate 5 cats killed 1,000 young Pheasants, and 200 predatory cats engaged in killing birds were killed in 3 years.[59] Cats running wild on the Island of Aldabra, Africa, have exterminated an interesting and unique bird, the Flightless Rail, and in 1898 were rapidly annihilating 13 native species of birds on Chatham Island.[60] Reagan, an authority on predaceous birds and mammals, who spent a great deal of time in investigating their

[56] Forbush, "The Domestic Cat: Bird Killer, Mouser, and Destroyer of Wild Life: Means of Utilizing and Controlling It," *Mass. Board of Agriculture, Economic Biology, Bull.* 2, 1916.
[57] Sullivan, *Economic Value of Bird Life*, 14, 1912.
[58] Forbush, "Facts about Cats," *Bird-Lore*, XVII, 165-167, 1915. See also *Bird-Lore*, XVII, 253, 1915.
[59] Job, "Propagation of Upland Game Birds," *Nat. Assn. Audubon Soc., Bull.* 2, 70-71, 1915.
[60] Palmer, *Yearbook U. S. Dept. Agric. for* 1898, 90.

habits and economic relations, says that the domestic cat "destroys in the aggregate more wild birds and young poultry than all the native natural enemies combined." [61] Lantz, in his study of the field mice, reached the following conclusion in regard to the cat: [62]

"The ordinary farm cat is exceedingly destructive to small birds and game, and the number that cats annually kill is immense. House cats are usually too well fed to make good mousers, and are believed to aid in the spread of diseases among human beings. In spite of the usefulness of *individual* cats in destroying mice, every community would be better off for a large reduction in its feline population."

Campbell, in urging legislative action in Australia to make owners of cats responsible for the action of the cats if allowed to run at large, said: [63]

"The extent of the destruction of young birds by even the pet cats of the household in country and suburban districts is appalling."

One need not wonder that naturalists everywhere look upon the cat with misgiving. Societies having for their object humanity to lower animals have recognized the menace of the cat. It is reported that the Society for the Prevention of Cruelty to Animals caused 174,925 cats to be put to death in New York City alone in 1914.[64]

Legislation aimed at the control of cats and the prevention of the destruction of birds thereby has been attempted in many places and actually put into operation in some localities.[65] In California the experiment of manicuring pet cats to prevent them from catching birds has been tried with

[61] Fisher, "The Economic Value of Predaceous Birds and Mammals," *Yearbook U. S. Dept. Agric. for* 1908, 187-194. Allen, *Auk*, XXVII, 100, 1910.

[62] Lantz, "An Economic Study of Field Mice," *U. S. Biol. Surv., Bull.* 31, p. 42, 1907; *U. S. Dept. Agric., Farmers' Bull.* 896, 1917.

[63] Campbell, *The Emu*, V, 201-202, 1906; quoted in *Auk*, XXIII, 358-359, 1906.

[64] Pearson, *Bird-Lore*, XVII, 408-409, 1915. *Auk*, XXXI, 145, 1914.

[65] *Bird-Lore*, XXI, 330, 1919; XVII, 408-409, 1915.

success.[66] If that could be done with all cats of acknowledged ownership and the myriads of strays summarily disposed of, much good would be accomplished.

The Millinery Trade.—Lest the fair sex feel slighted, it may be said that while the slaughter of game birds by sportsmen and market hunters has been in progress, the destruction of non-game birds for millinery purposes has been as great or greater. The terrific drain of the feather trade upon bird life in the past century, not yet altogether terminated, is but little appreciated by those responsible for it. It would stop at once if women everywhere would refuse to buy the feathers and skins. "Adornment" of hats by such means is a barbarous custom, anyhow, and seldom adds to the attractiveness of the wearer.

Since dealers have discovered that the world is awakening to the enormity of the trade and its disastrous results, general statistics on the subject, especially with reference to our native, law-protected birds, are unobtainable. Isolated items become known from time to time, and a few of these culled from various sources may throw some light upon the subject. Many of the birds used are of species that range over the United States in summer, but retire to Central or South America for the winter, so that their destruction even far southward directly affects the people of the United States. The slaughter will continue in out-of-the-way places as long as the market furnishes a demand for plumage.

The work of the Audubon Societies and other organizations and individuals in discouraging the use of plumage has produced good results. Most non-game birds are now theoretically protected by law in most American States and some foreign countries. A decisive blow to the trade would be the adoption everywhere of laws prohibiting the importation of foreign plumage, as well as forbidding the wearing of plumage of wild birds. In 1913 the movement for the general restriction of the traffic in bird skins began to have its effect, with

[66] *Calif. Fish and Game*, V, 82, 1919.

the adoption of a law prohibiting their importation into the United States, a pending bill of the same sort in Great Britain, and favorable discussion of such laws in Germany, Holland, Denmark, Austria, Switzerland and Australia. The effect of the passage of the American law was immediate and shows what can be done to check the extermination of some of the most beautiful birds in the world if a few leading nations would adopt and enforce stringent laws on the subject. Within ten days after the signing of the law by President Wilson the decline in the London feather market began, and out of 1174 lots offered for sale at the auctions 368 were withdrawn "because of bad prices and no buyers." [67]

Any doubt that the millinery trade has been responsible for the practical extermination of several very beautiful birds and a great decrease in many others will be set at rest by the perusal of the testimony given before a committee of the United States House of Representatives at a hearing on the proposal to prohibit the importation of feathers of wild birds.[68] The list of over 100 species threatened with destruction includes the various species of Birds of Paradise, Crowned Pigeon, Scarlet Ibis, Egrets, Resplendent Trogon, Lyre Bird, Cock of the Rock and other very beautiful creatures. As early as 1901 it was stated that the Namo, a bird of the Hawaiian Islands, had been exterminated for its feathers and that "the Oo must soon share its fate." [69] Beebe, who has made a special study of the beautiful Asiatic Pheasants, says that many of the species are fast nearing extinction.[70]

Various fairy stories put into circulation by the feather trade, to the effect that the plumes marketed are the moulted feathers picked up from the ground or plucked from live birds in captivity on bird farms are without the slightest foundation in fact, except as to the Ostrich plumes from the Ostrich

[67] *Auk*, XXXI, 289-290, 1914.

[68] Tariff: Schedules: Hearings before the Committee of Ways and Means, House of Representatives, on Schedule N—Sundries, Gov. Ptg. Office, Wash., 1913, 5307-5348.

[69] Henshaw, *Bird-Lore*, III, 158, 1901.

[70] Forbush, 4th Ann. Rept. *Mass. State Ornith.*, 26, 1912.

farms. The feathers of Egrets and other wild birds are obtained by killing the birds, mostly during the nesting season, when the plumage is at its best, thus not only destroying the adult birds, but preventing reproduction or causing the death of the nestlings by starvation;[71] hence the tremendous havoc of the business. That such a cruel business should ever have had the general support of the fair sex is explainable only on the theory that they were ignorant of the facts. Moulted feathers are almost altogether worthless and cannot be obtained in quantity, and moulted wings and skins are entirely impossible.

A glance at some of the available millinery statistics is instructive. In 1878 it was estimated that there were 3,000,000 White Egrets in Florida alone, but so swift was their destruction that 10 years later they were scarce everywhere.[72] The Egrets and other members of the Heron family are particularly susceptible to attack and easily killed because of their habit of nesting in colonies.[73]

Palmer tells us that one gunner in 1883 marketed 3,000 Terns from Long Island; that about the same time 40,000 of them were said to have been killed at Cape Cod; that two men at Tampa Bay, Florida, had a contract for the delivery of 30,000 Terns in one season; that one man employed from 40 to 60 gunners in shooting Herons during the nesting season for their plumes; another boasted that he had killed 300 Herons in one afternoon; while two others claimed to have killed 130,000 Herons, Egrets and Terns in one season.[74]

According to Forbush,[75] in Oregon, from 1900 to 1908, from 20 to 30 camps were engaged in killing Grebes for the feather trade;[76] over 1,500,000 Egrets were killed in Venezuela in

[71] Dutcher, "The Horrors of the Plume Trade," *Special Leaflet* No. 21, Nat. Assn. of Audubon Societies.
[72] Sullivan, *Economic Value of Bird Life*, 13-14, 1912.
[73] Cooke, *U. S. Biol. Surv., Bull.* 45, 7, 1913.
[74] Palmer, *Yearbook U. S. Dept. Agric. for* 1899, 272-274.
[75] Forbush, 4th Ann. Rept. *Mass. State Ornithologist*, 1911 (24th Ann. Rept. *Mass. State Board Agric.*, 26-27).
[76] See also Bailey, *Bird-Lore*, II, 34, 1900. *Bird-Lore*, VII, 339-340, 1905.

1898 for their plumes; 400,000 Hummingbird skins were shipped from the West Indies to 1 London dealer in 1 year; 2 dealers for some years prior to 1907 shipped 12,000 Bird of Paradise skins every 3 months; and 250,000 Albatrosses were killed in 1 year on Pacific Islands.

Sullivan [77] says that 70,000 song birds were killed on Long Island in 4 months, and that at one auction in London 400,000 bird skins from America and 350,000 from India were sold. Not many years ago 1 London sale involved 19,029 Bird of Paradise skins.[78]

Ridgway,[79] in his report on the Hummingbirds, says that 3,000 skins of these beautiful birds were included in a single consignment from Brazil in 1888, 12,000 were sold in London in 1 day, and 400,000 skins, mostly Hummingbirds, were sold at auction in the same city and the same year, in 1 week. Ten tons of Ptarmigan skins were shipped from Russia in a single consignment.[80] Three auction sales alone in London in 1911 involved skins of 129,168 Egrets, 13,598 Herons, 20,698 Birds of Paradise, 41,090 Hummingbirds, 9,464 Eagles and Condors and 9,470 other birds.[81] In 1 wareroom 60 tons of feathers of the wild South American Rhea were found, and 34 tons were exported from Buenos Aires in 6 months in 1913.[82] Such feathers have been admitted to the United States as Ostrich feathers, though the birds do not belong to the Ostrich family. The bright plumage of Orioles of various species has led to great slaughter, especially in Central America.[83]

In 1909, 15 Japanese subjects were arrested by the United States Revenue Cutter Thetis for poaching on Laysan, Hawaiian Islands, with 119,000 bird wings in their possession, having previously shipped 128,000, and 8 more Japanese,

[77] Sullivan, *Economic Value of Bird Life*, 13, 1912.
[78] *Museum News*, VII, 54, 1912.
[79] Ridgway, Ann. Rept. *U. S. Natl. Museum for* 1890, 256.
[80] Judd, *U. S. Biol. Surv., Bull.* 24, 47, citing Engelhardt, *A Russian Province of the North*, 1899. Oldys, *Yearbook U. S. Dept. Agric. for* 1902, 207-208.
[81] *Testimony before Congressional Tariff Committee*, 1913, 5317.
[82] Miller, *Bird-Lore*, XVI, 259-262, 1914.
[83] Howell, *U. S. Biol. Surv., Bull.* 25, 9, 1906.

arrested on Lisiansky, had about 140,000 wings and had shipped about 108,000.[84] Thousands of Albatrosses were at one time imprisoned on the Hawaiian Islands by feather poachers, to die of starvation, so as to absorb the fat before death and thus make the plumage easier to prepare for the market.

"Only the thoughtless and ignorant still hold that the graceful forms and beautiful plumage of these masterpieces of Nature [birds] serve their highest purpose when worn on a hat for a brief season, to be then cast aside and forgotten, the plumage dimmed and faded, the beautiful songs quenched forever." [85]

[84] *Army and Navy Register*, Feb. 19, 1910, quoted at length in *Auk*, XXVII, 243-244, 1910. See also *Testimony before Cong. Tariff Comm.*, 1913, 5325-5326.

[85] Henshaw, *Yearbook U. S. Dept. Agric. for* 1907, 165.

XVII

REMEDIES

Many things can be done not only to prevent undue destruction of birds, but also to encourage them and increase their numbers where advisable. Foremost among these is the creation of a healthy public sentiment by the dissemination of accurate information. An astonishing number of otherwise well-informed people are totally ignorant of the practical value of birds—their relation to human welfare. Much is being done to correct this. Much more should be done.

The interest of thousands of school teachers has been enlisted and they have introduced the study of birds into the curricula of their schools, but there are large areas where nothing of this kind has yet been done. The Audubon Societies, with their junior organizations, are doing splendid work along this line, a work that should be pushed into every corner of the land. In a great many localities the Boy Scout, Girl Scout and kindred movements are doing good work in interesting the youth of the land in Nature, including the birds. It is quite customary in some portions of the country to call upon the Boy Scouts to post notices in the forests and along the highways, urging people to protect the birds and spare the wild flowers. Such organizations should be given every possible encouragement and every effort should be made to get executives for the organizations who are themselves well trained, in order that the information they pass along to the boys and girls may be accurate. Many newspapers are willing to give space to articles bearing upon this subject, and such articles should be prepared by men and women who have made sufficient study of the subject to avoid misleading statements.

Much may be done by those interested in the study of birds to encourage the newspapers of their localities to devote more space to the subject, in connection with other phases of natural science, and to furnish the editors with information.

Such a campaign of education is essential to the passage of wise laws for the protection of birds, but the passage of laws cannot solve the problem. Laws will not be enforced without enthusiastic public sentiment behind them. A sufficient police force to patrol the whole country and watch for violations of the law is not practicable. Furthermore, the great majority of officers charged with the enforcement of laws do not even know there are any laws for the protection of any but the game birds, have not the slightest knowledge of the need of such protection or of the importance of birds, and are totally devoid of any interest in the subject. Hence our chief hope lies in the educational campaign, the dissemination of knowledge, the creation of public sentiment based upon that knowledge.

A number of sportsmen's associations in the United States are engaged in intelligent patriotic efforts to conserve game birds. Many of their members are also interested in the protection of non-game birds. They should receive support in all proper endeavors. It is not at all advisable to prevent hunting, but it is quite important to place it under proper control; otherwise in a short time there will be no hunting. Extreme sentimentalists who demand complete cessation of hunting in most cases eat the flesh of fishes and mammals killed in quite as cruel ways as is the game killed by the hunter. The need is of intelligent conservation in the interests of all the people, and that is what most sportsmen's organizations are seeking. They may sometimes make mistakes, as we all do, but their motives are usually good and mistakes can usually be corrected if detected in time.

The early bird laws of the United States provided for the destruction of birds by means of bounty acts, instead of their protection. Especially were laws directed against such gre-

garious birds as the Blackbirds and Crows, because they were generally supposed to be altogether harmful to crops, and against the Hawks and Owls, because they were all suspected of being enemies of the poultry. Subsequent investigation has shown that the Blackbirds and Crows do a great deal of good to offset the damage they do, and only a few species of Hawks and Owls cause trouble in the poultry yards, while the great majority do a vast amount of good in the destruction of injurious rodents and insects. Consequently, such laws are not now very much in vogue.

Through the efforts of the United States Department of Agriculture, the American Ornithologists' Union, the National Association of Audubon Societies and other organizations and individuals, most states have enacted laws for the protection of all except a few species of non-game birds, while the national government has negotiated treaties with adjacent countries providing for protection of migratory birds, and Congress has enacted a law providing for the regulation of hunting migratory birds, under the terms of the treaties.

A number of very important bulletins and other publications dealing with methods of attracting birds[1] have been published during the past few years. Among the suggestions offered, an important one is the provision of feeding places and food for birds during bad weather and times of scarcity of food. Another is the planting of wild fruits and other non-commercial fruits attractive to the birds and affording them a substitute for cultivated fruits in order that they may not be so strongly tempted by ripening cherries.

The provision of better nesting places is very necessary

[1] McAtee, "How to Attract Birds in the Northeastern United States," *U. S. Dept. Agric., Farmers' Bull.* 621, 1914; "How to Attract Birds in Northwestern United States," *Farmers' Bull.* 760, 1916; "How to Attract Birds in the East Central States," *Farmers' Bull.* 912, 1918; "Attracting Birds to Public and Semi-public Reservations," *U. S. Dept. Agric., Bull.* 715, 1918; "Plants Useful to Attract Birds and Protect Fruit," *Yearbook U. S. Dept. Agric. for* 1909, 185-196. Beal, *Yearbook for* 1900, 303-304; *U. S. Biol. Surv., Bull.* 30, 11. Kennard, "A List of Trees, Shrubs, Vines, and Herbaceous Plants Native to New England, Bearing Fruit or Seeds Attractive to Birds," *Bird-Lore*, XIV, 201-203, 1912.

where natural nesting sites are scarce. For species that nest in holes, enclosed bird boxes may be provided, of different sizes and especially with openings of different sizes for various species.[2] In many places small piles of brush may be so placed as to provide nesting cover for ground-nesting species. The value of encouraging the nesting of birds has been demonstrated on more than one occasion. For example, Forbush tells us that an invasion of army worms in Massachusetts did no harm on farms where provision has been made for nesting sites.[3] Hewitt says that in 1905, in a large area in Germany, when insects were defoliating the trees, the wood of Baron von Berlepsch, in which birds had been encouraged by numerous nesting boxes, was almost untouched by the insects, which were kept in check by the birds.[4] The Baron has written a book on Methods of Attracting and Protecting Wild Birds, and Wharton has from his own observations given us a shorter account of the methods adopted.[5]

The necessity of protecting birds, particularly during the nesting season, from stray house cats has been discussed at some length in another chapter. As therein indicated, a large proportion of young birds about farms, villages, towns and cities, upon leaving the nests, become victims of cats. If all the cats could be kept in confinement during the nesting season, it would immediately result in a large increase in the numbers of insectivorous birds. Manicuring the cats has also been found effective. Cat-proof wire fences, which prevent the cats from entering enclosures where birds are nesting, and guards for the trunks of trees, which prevent cats from climbing them after young birds in the nest, have been devised.[6] Anti-cat ordinances have been passed in some cities and proposed in others,[7] but they have not proved popular, because

[2] Dearborn, "Bird Houses and How to Build Them," *U. S. Dept. Agric., Farmers' Bull.* 609, 1914.
[3] Forbush, *Bird-Lore*, XVI, 400-401, 1914.
[4] Hewitt, *Ottawa Naturalist*, XXVII, 166, 1914.
[5] Wharton, *Bird-Lore*, XVI, 329-337, 1914.
[6] McAtee, *U. S. Dept. Agric., Farmers' Bull.* 760, pp. 2-3, figs. 1-3, 1916.
[7] *Bird-Lore*, XXI, 330, 1919; XXII, 263, 1920.

of ignorance of the facts, and are bitterly opposed by those who believe that their cats should be allowed to run at large regardless of the rights of their neighbors.

The establishment of properly guarded private and public bird preserves—areas in which the destruction of birds of all kinds is prohibited at all seasons—is another means of encouraging the birds and maintaining their existence or even increasing their numbers locally. Numbers of such refuges have been provided, but the plan is capable of great extension and doubtless much more will be done in that direction in the future. The setting aside of their breeding places as refuges is an especially valuable method of preventing the extermination of such birds as the Egrets. The desperate character of the market hunters is revealed by the fact that wardens of some such preserves have been killed by the collectors of plumage for the hats of the fair sex—a business unintentionally encouraged by those who demand the plumage.

PART II

SYSTEMATIC DISCUSSION

ORDER PYGOPODES. DIVING BIRDS

This Order, if it be not divided, as is sometimes done, includes the Grebes, Loons, Puffins, Auks, Auklets, Murrelets, Murres, Guillemots, Dovekies and so forth. Though Ducks and some other birds dive, this is preëminently the Order of Diving Birds. They live to a great extent, some species perhaps almost exclusively, upon small fishes, which they obtain by diving and swimming under water. So thoroughly aquatic are they that some species have practically or entirely lost the power of flight.

Family COLYMBIDÆ. *Grebes*

These are the birds popularly known among the hunters as "Hell-Divers," though by less discriminating persons that name is sometimes applied to other members of the Order. Grebes are more generally distributed than other families of this Order and not so gregarious as most of the others, but in some localities certain species have been known to nest in considerable colonies. This, together with the fact that the breast plumage of these birds was desired by the feather trade, has at times led to their destruction in great numbers. From 1900 to 1908 there were from 20 to 30 camps of men about the lakes of southern Oregon engaged in killing and skinning Grebes for the feather market,[1] which led President Roosevelt to set aside Klamath and Malheur Lakes as bird reservations.[2] Probably the same thing was going on wherever the Grebes were found in sufficient abundance.

[1] Forbush, 4th Ann. Rept. *Mass. State Ornith.*, 27, 1912.
[2] Bent, *U. S. Natl. Museum, Bull.* 107, 4, 1919.

Grebes are not so strongly addicted to a fish diet as is generally supposed. The vegetable portion of their diet makes them good table birds.[3] Allen says they feed also on aquatic insects.[4] This difference in habit from the more exclusive fish eaters is reflected in the character of their bills and tongues.[5]

Two Eared Grebes (*Colymbus nigricollis californicus*) contained 14 grasshoppers, a few other insects, crayfish and part of a fish.[6] Stomachs of 57 Horned Grebes (*Colymbus auritus*) contained feathers up to 66%; but ignoring the feathers, the balance consisted of beetles, 23.3%; other insects nearly 12%; fishes, 28.7%; crayfish, 20.7%; other crustaceans, 13.8%; snails, spiders and vegetation in small amounts.[7] The Grebes' peculiar habit of swallowing feathers in large quantities, though but little understood, has been mentioned by many writers. It is reported that even chicks 3 days old are found to be stuffed with feathers. Chapman says that in one juvenile individual he found 238 feathers and in another 331, all being the body feathers of adult Grebes.[8] Wetmore says that the feathers are most abundant in stomachs of Grebes that contain fish remains and hard-bodied insects, and suggests that their purpose may be to strain out the bones, etc., and prevent them from getting where they would damage delicate tissues.[9]

The Western Grebe (*Æchmophorus occidentalis*) has been known to feed upon aquatic plants and along the seashore it feeds upon small herrings, while the food of the Holboell Grebe (*Colymbus holboelli*) consists of small fishes, amphibians, crustaceans, aquatic insects, worms, fresh-water mollusks and a little vegetation, according to Bent. He also quotes Roberts as having found 327 dragonfly nymphs in one stomach of

[3] Judd, *U. S. Biol. Survey, Bull.* 17, 79, 1902.
[4] Allen, *Cornell Reading-Courses*, IV, No. 76, 33-34, 1914.
[5] Allen, *ibid.*, p. 34. Gardner, *Proc. U. S. Natl. Museum*, LXVII, 11, 1925.
[6] Aughey, 1st Rept. *U. S. Entom. Comm.*, App. II, 62, 1978.
[7] McAtee and Beal, *U. S. Dept. Agric., Farmers' Bull.* 497, 18-19, 1912.
[8] Chapman, *Camps and Cruises of an Ornithologist*, 332, 1908.
[9] Wetmore, *U. S. Dept. Agric., Dept. Bull.* 1196, 4, 1924.

this species,[10] but Roberts' statement was clearly concerning the Franklin Gull, not the Grebe.[11] One Holboell Grebe in captivity ate fish, raw beefsteak, tadpoles, dragonflies, crayfishes and earthworms.[12]

The latest and best discussion of the food of North American species of Grebes is by Wetmore,[13] who investigated them because they were accused by fishermen of being detrimental to food and game fishes. He asserts that "this suspicion is without actual foundation in fact." The following is a summary of some of the important items in his report, the feather content of the stomachs being ignored in figuring the food percentages:

Western Grebe (*Æchmophorus occidentalis*), 19 stomachs; all contained feathers, 4 containing nothing else; 15 contained food, almost entirely small fishes, chiefly chubs, suckers, carp and smelt; the first 3 are destructive to fish eggs, hence to the birds' credit; the few smelts taken could have but little effect upon the vast schools of these fishes; a few water boatmen were found in 1 bird and 2% of rootlets in another; Macoun reports that 1 examined by him contained a large salamander (pp. 5-7.)

Holboell Grebe (*Colymbus holboelli*), 46 stomachs; 10 contained only feathers, 36 contained 70% of feathers; of the food—fishes, 55.5%, found in 23 stomachs and the only food in 14, chiefly sticklebacks (destructive to other fishes), sculpins and top minnows (of very slight value), 1 eel and some perch; crustaceans, 20% of total, 75% in 1; insects 21.5%; vegetation 3%; no June stomachs, which, if available, would doubtless have increased the proportion of crustaceans and insects to fishes. (pp. 7-10.)

Horned Grebe (*Colymbus auritus*), 122 stomachs; 8 contained only feathers, 114 contained 55.5% feathers; of the

[10] Bent, "Life Histories of North American Diving Birds," *U. S. National Museum, Bull.* 107, 7, 14, 32, 1919.
[11] Roberts, *Auk*, XVII, 282, 1900.
[12] Sim, *Wilson Bull.*, XVI, No. 48, p. 68, 1904.
[13] Wetmore, "Food and Economic Relations of North American Grebes," *U. S. Dept. Agric., Dept. Bull.* 1196, 1924.

food—vegetation (in 6 birds), 1%; fishes, 34.6% (in 49 birds), chiefly small fishes of little value, such as sculpins, some destructive, as carp and sticklebacks; crustaceans, 17.9%; insects, 46%; no July stomachs, which, if available, would have increased the percentages of crustaceans and insects. (pp. 10-15.)

Eared Grebe (*Colymbus nigricollis californicus*), 27 stomachs; feathers, only 27%; only 5 contained fish remains, 9.8% of total food; insects 40% (dragonflies, 19.5%; beetles, 14.3%), found in 13 birds, 1 containing 1300 water boatmen, 1 containing 1139 insects, including 315 weevils, 650 water scavenger beetles and 170 other beetles; miscellaneous animal matter, 5.5%, including crustaceans, worms, fresh-water snails and a frog. (pp. 15-18.)

Mexican Grebe (*Colymbus dominicus brachypterus*); but little information available; probably lives largely upon aquatic insects; no stomachs seem to have been examined except 1 by Gosse in 1847, reported to have been filled with finely-ground material, suggesting feathers, such as have since been found in other Grebes.

Pied-billed Grebe (*Podilymbus podiceps*), 180 stomachs; feathers, 52%, 6 containing nothing else; of the food—vegetation, small amount in 3 birds; fishes, only 24.2%, found in only 69 birds, mostly of slight value, 1 stomach containing 8 and another 17 carp; crayfishes, 27%; other crustaceans, 4.1%; insects, 46.3% (Heteroptera, 16.2%; Coleoptera, 16.1%; dragonflies and damselflies, 8%); other animal matter, 2.1%, including aquatic mollusks, spiders and frogs.

Antillean Grebe (*Podilymbus podiceps antillarum*), 1 Porto Rican stomach contained 2 dragonflies, 25 crayfishes, with feathers 65% of entire contents.[14] Another Grebe, perhaps of the same sub-species, from the same island, contained 3 crayfishes and remains of a small mammal, probably a rat.[15]

[14] Wetmore, *U. S. Dept. Agric., Bull.* 326, 45, 1916.
[15] Bowdish, *Auk*, XIX, 357, 1902.

Family Spenisciformes. *Penguins*

Penguins are birds of the Antarctic region, and though locally abundant, their colonies are too remote from large communities of human beings to affect the human race very much, but their droll appearance and habits make them exceedingly interesting birds to study. Their almost exclusive fish diet is correlated with tongues armed on the upper surface with sharp spines turned backward to enable them to firmly hold their slippery prey.[16]

Family Alcidæ. *Auks, Murres, Puffins, etc.*

Like the Penguins, these birds are not generally distributed, but are locally abundant within their ranges, which are remote from dense human populations. Though the adults are generally supposed to feed chiefly upon small fishes, Palmer reports Paroquet Auklets and Pallas Murres feeding their young with great quantities of crustaceans.[17] Fisher reports hundreds of Puffins circling over him, each with from 1 to 5 sticklebacks in its beak for the young.[18] Townsend found that the food of the Crested and other Auklets consists to a considerable extent of amphipod crustaceans, which are "amazingly abundant in Alaskan waters, and, as a never-failing food supply, account for the surprising abundance of Auklets of all kinds."[19]

It is humiliating to note that the largest and most interesting species of this family, the Great Auk, has been totally exterminated within the past century through the activities of human beings. A very extensive literature has grown up about this bird.[20] It was a flightless species, and a century ago

[16] Gardner, *Proc. U. S. Natl. Museum*, LXVII, 6, 1925.
[17] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 433, citing Palmer, *Fur Seals and Fur Seal Islands*, Pt. 3, 385-391, 1899.
[18] Per Judd, *ibid.*, 433.
[19] Townsend, "The Crested Auklet" (Nat. Assn. Aud. Soc., Leaflet No. 65), *Bird-Lore*, XV, 134-135, 1913.
[20] See Lucas, "The Expedition to Funk Island, with Observations upon the History and Anatomy of the Great Auk," *Ann. Rept. U. S.*

it occurred in "countless myriads" in a few colonies along the coasts of Newfoundland and northern Europe. Its inability to fly, its highly gregarious nesting habit and its lack of more general distribution made it peculiarly susceptible to attack by man. Its eggs were taken in great quantity by navigators and others for food, thus reducing its numbers, then when its destruction for the feather market began its annihilation was so sudden that very few of the skins and eggs were obtained for the museums of the world, to show future generations what they were like. When, on rare occasions, specimens show up in old collections and are put up for sale at auction, they bring almost unbelievable prices.[21] Townsend quotes Fabricius thus: [22] "The Great Auk fed on *Cottus scorpius*, or the bullhead, and *Cyclopterus lumpus*, or the lump fish, and other fishes of the same size." One in captivity ate potatoes and milk, besides fish.

Audubon [23] said that the food of the Razor-billed Auk (*Alca torda*) "consists of shrimps, various other marine animals and small fishes, as well as roe."

Bent's report [24] furnishes the following items concerning the food of Puffins: Puffin (*Fratercula arctica arctica*), food is almost exclusively fish, and on the Labrador coast the capelin seems to be their favorite; crustaceans and other forms of marine life are also doubtless eaten. (p. 93, quoting Townsend.) Large-billed Puffin (*F. a. naumanni*), feeds upon fishes, crustaceans, etc. (p. 97.) Horned Puffin (*F. cornicula*), "food consists chiefly of small fishes, such as sand lances, sticklebacks and smelt," but quotes Turner (1886) thus: "Their food is composed of mollusks of various kinds, a few shreds of certain seaweed fronds, and larvæ, which are

Natl. Museum for 1888, 493-529, including an extensive bibliography. There are also many more recent references not included in the bibliography.

[21] See, for example, *Science*, XIX, 967, 1904; *Museum*, I, 325; *Oologist*, XXV, 60; *Auk*, XXIX, 208.

[22] Townsend, in Bent, "Life Histories of North American Diving Birds," *U. S. Natl. Museum, Bull.* 107, 209-215, 1919.

[23] See Bent, *U. S. Natl. Mus., Bull.* 107, 205, 1919.

[24] Bent, *U. S. Natl. Mus., Bull.* 107, 1919.

abundant on some of the seaweeds." (p. 102.) Tufted Puffin (*Lunda cirrhata*), food mostly fishes, such as smelt, sardine, herring and perch, but includes also mollusks, sea urchins and other marine animals and algae; quotes Emerson: "The food of the young consists of shellfish, sea urchins, small smelt, sardines, herring and perch." (pp. 85-86.)

The following Auklet items are condensed from Bent's report: [25] Least Auklet (*Æthia pusilla*), food mainly crustaceans. (p. 31.) Whiskered Auklet (*A. pygmæa*), principal food gammerid crustaceans, but other crustaceans and gastropods have been found in stomachs.[26] (p. 127.) Crested Auklet (*A. cristatella*), food "mainly crustaceans and other small marine animals"; Stejneger found 1 filled with violet-red semifluid, which he assumed [probably erroneously] to have been derived from cephalopod. (p. 127.) Paroquet Auklet (*Phaleris psittacula*), food mainly crustaceans; quotes Nelson (1887) thus: "At Plover Bay every one shot had its craw distended with small crustaceans." (p. 118.) Cassin Auklet (*Ptychoramphus aleuticus*), stomachs examined by Stephens [27] contained shrimps, and Heath reports that the food of both young and adult consists of copepod and amphipod crustaceans,[28] but Bent adds that "probably a great variety of small marine animals are included in its diet." (p. 114.) Rhinoceras Auklet (*Cerorhinca monocerata*); quotes Grinnell [29] concerning 10 California specimens: "The food consisted entirely of a small yellow crustacean, which filled their gullets." (p. 107.) Linton says: [30] "Craws examined contained freshly-caught sardines, 3 to 4 inches long; stomach contents, meat and bones of small fish." Heath [31] says the food of both young and adult "consists wholly of sand launces, according to the reports of the natives, and an examination of a few stomachs supports their claim."

[25] Bent, *U. S. Natl. Museum, Bull.* 107, 1919.
[26] Citing Stejneger, *U. S. Nat. Museum, Bull.* 29, 1885.
[27] See Stephens, *Auk*, X, 299, 1893.
[28] Heath, *Condor*, XVII, 34, 1915.
[29] See Grinnell, *Bull. Cooper Ornith. Club* (*The Condor*), I, 19, 1899.
[30] Linton, *Condor*, X, 125, 1908. [31] Heath, *Condor*, XVII, 33, 1915.

Concerning the Murrelets, Bent's report furnishes the following items: [32] Ancient Murrelet (*Brachyramphus antiquus*); food, various small marine invertebrates. (p. 138.) Xantus Murrelet (*B. hypoleucus*); stomachs do not contain oil, as has been stated, but a little green slime, likely derived from marine plants; diet probably chiefly crustaceans and minute marine life. (p. 152.) Kittlitz Murre (*B. brevirostris*); quoting Grinnell: [33] "Their principal diet was a slippery slug-like animal about an inch long"; quotes Nelson (1887) as saying that the birds appeared to be "feeding upon small crustaceans." (pp. 146-148.) Marbled Murrelet (*B. marmoratus*); food seems to consist chiefly of fishes; quotes Grinnell [34] as finding that 1 bird contained fishes 3 inches long, and that small fishes "seemed to be the standard article of food, but dissection of the stomachs also showed remains of some small mollusks." [35]

Bent's items concerning the food of Murres are here condensed: [36] Murre (*Uria troille troille*); food "consists largely of lant, capelin and other small fishes," but it also takes crustaceans, marine insects and other soft-bodied sea animals; quotes Morris [37] as saying that it feeds "on sprats, young herrings, anchovies, sardines and other fish, mollusca, testacea and sea insects." (p. 180.) California Murre (*U. t. californica*); food habits do not differ from preceding to any extent. (p. 187.) Brunnich Murre (*Uria lomvia lomvia*); food mainly of fish, crustaceans and mollusks; quotes Figgins as saying that "their food consists largely of marine insects and salmon-colored ovate eggs, or larvae, not determined." (p. 194.) Pallas Murre (*U. l. arra*); quotes Palmer (1899) thus: "Like probably all their congeners, the small young are fed by disgorged crustaceans, but I know that the larger young and even small individuals are fed upon whole fish." (p. 198.)

[32] Bent, *U. S. Nat. Mus., Bull.* 107, 1919.
[33] Grinnell, *Univ. Calif. Pub. in Zool.*, V, 171, 1909.
[34] Grinnell, *Univ. Calif. Pub. in Zool.*, V, 361, 1910.
[35] See Grinnell, *Osprey*, I, 115, 1897.
[36] Bent, *U. S. Nat. Mus., Bull.* 107, 1919.
[37] Morris, *A History of British Birds*, 5th Ed., 1903.

The following items concerning the food of Guillemots are also from Bent's report: [38] Black Guillemot (*Cepphus grylle*); on the Maine coast feeds largely on small rock eels, but eats also small mollusks, marine insects, worms and crustaceans; several stomachs contained crustaceans only, others contained a semiviscid fluid probably derived from the digestion of crustaceans. (p. 160.) Mandt Guillemot (*C. mandti*); food "seems to consist mainly of small fishes, crustaceans and other soft-bodied sea animals." (p. 164.) Pigeon Guillemot (*C. columba*); food "seems to consist of small fish, mollusks, crustacea and other marine animals," and Grinnell [39] saw one flying "with a large yellow marine worm hanging from her bill."

Bent [40] says that young Dovekies (*Alle alle*) are fed largely upon crustaceans and probably the adult food is the same. He quotes Audubon (1840) as finding crustaceans and "particles of seaweed" in their stomachs; and Nuttall (1834) as including marine insects and crustaceans in their diet; and Brewster [41] as finding several stomachs filled with young alewives.

Family Gaviidæ. *Loons*

The Loons have the bases of their tongues much better armored with backward-projecting spines than have the Grebes, a characteristic probably correlated with their stronger inclination toward a fish diet.[42] They are widely distributed but not gregarious and too uncommon to be of great practical value to the human race. They should be fully protected because of their esthetic and scientific interest. The fishes they take are mostly small species of very little value and they do not take enough to do much, if any, harm. On the other hand, it is not improbable that they do some good by keeping

[38] Bent, *U. S. Nat. Mus., Bull.* 107, 1919.
[39] See *Univ. Calif. Pub. in Zool.*, V, 361, 1910.
[40] Bent, *U. S. Nat. Mus., Bull.* 107, 219, 1919.
[41] See Brewster, *Mem. Nuttall Ornith. Club*, No. 4, 1906.
[42] Gardner, *Proc. U. S. Natl. Museum*, LXVII, 1925; compare Plate 4, figs. 23 and 24.

in check certain destroyers of the eggs of game and food fishes.[43]

Audubon long ago reported finding in Loon stomachs amphibians, aquatic insects, leeches, coarse gravel and sometimes the roots of fresh-water plants, in addition to fishes. Nelson, according to Judd, reports a downy chick of the Black-throated Loon (*Gavia arctica*) with a six-inch tom-cod in its gullet.[44] As, owing to their fish diet, their flesh is not very palatable (though eaten by Eskimo and some Caucasians), when shot by hunters they are usually cast aside and allowed to putrify on the shore, a total loss.

Bent's report on the Diving Birds [45] contains the following items concerning Loons: Loon (*Gavia immer*); feeds largely on fishes, but probably does very little harm; 1 contained 15 flounders averaging about 4 inches in length, and a mass of partly digested fishes; in some individuals aquatic insects, amphibians, leeches and aquatic plants have been found; quotes Warren [46] concerning 7 winter stomachs containing only fish remains and 2 winter birds that had been feeding upon roots and seeds. (pp. 47-60.) Yellow-billed Loon (*Gavia adamsi*); stomachs examined by Collett [47] were filled with fishes and a little gravel. (pp. 60-65.) Pacific Loon (*Gavia pacifica*); nothing published except occasional references to seeing one flying with fish in its bill; probably feeds chiefly on small fishes. (p. 70.) Red-throated Loon (*Gavia stellata*); food chiefly small fishes, but includes also amphibians, mollusks, leeches, aquatic insects and probably aquatic plants.

[43] Norton, "The Loon," (National Assn. of Audubon Societies, Leaflet No. 78), *Bird-Lore*, XVII, 68-71, 1915.
[44] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 433, citing Nelson, *Nat. Hist. of Alaska*, 37, 1887.
[45] *U. S. Nat. Mus., Bull.* 107, 1919.
[46] See Warren, *Birds of Pennsylvania*, 1890.
[47] See Collett, *The Ibis*, Ser. 6, VI, 269, 1894.

ORDER LONGIPENNES. LONG-WINGED SWIMMERS

The life histories of the North American species of birds of this order have been discussed monographically by Bent, including notes on food habits, from which important items have been taken for this volume.[1]

Family STERCORARIIDÆ. *Skuas and Jaegers*

The Skuas and Jaegers are sometimes called the pirates of the seas, because of their predatory habits. They feed largely upon fishes, which they obtain by robbery. They pursue Gulls and Terns, forcing them to drop the fishes they have caught, which the attacking birds then catch before they reach the water. They also eat other birds, especially the young, eggs, small rodents, carrion, etc.[2] Their bills are modified to more nearly resemble those of Hawks and Owls than Gulls.

The food of the Jaegers consists of stolen fish, with offal, carrion, young birds, eggs, mice, lemmings and other small rodents, insects, crustaceans, amphibians, mollusks, berries, and other food.[3] One Pomarine Jaeger (*Stercorarius pomarinus*) was observed to catch and eat a Phalarope.[4] One stomach contained remains of insects, crustaceans, frogs and fishes.[5] One Parasitic Jaeger (*S. parasiticus*) contained various insects and the bones of a small bird, probably a young Tern; another contained a dragonfly, various beetles and a

[1] Bent, "Life Histories of North American Gulls and Terns," *U. S. National Museum, Bull.* 113, 1921.
[2] Bent, *U. S. Nat. Mus., Bull.* 113, 10-11, 1921.
[3] Bent, *ibid.*, 10-11.
[4] Tuttle, *Auk*, XXVIII, 482, 1911.
[5] Aughey, 1st Rept. *U. S. Entom. Comm.*, 60-61, 1878.

small fish.[6] Anthony found stomachs of the same species "filled to overflowing with fish spawn." [7]

The food of the Skua (*Catharacta squa*) consists chiefly of fish, but includes also the smaller water birds and their eggs, and carrion. Two stomachs contained remains of Kittiwakes and one bird was seen killing a Herring Gull.[8]

Family Laridæ. *Gulls and Terns*

Some of the Gulls are very useful, and probably all are on the whole practically harmless. They are almost omnivorous, and though they take some small live fishes, usually of no importance as food for man, they have been found feeding upon ants and many other insects, sea urchins, starfishes, clams, crustaceans and all sorts of other animal life, while one even caught a bat.[9] They are especially prized as scavengers, for which reason they were among the first non-game birds to receive legal protection, especially about the harbors. They may be seen following ships and small boats, watching eagerly for any morsel of waste food that may be thrown away; or scouring the beaches in search of dead fishes or other refuse that would otherwise putrify and taint the atmosphere. They have often been observed in large flocks following city garbage boats out to sea and feeding upon the garbage. About the salmon canneries of the Pacific Coast from Oregon to Alaska they congregate in countless numbers to feed upon the waste from the cleaning of the fishes.

The best known and most spectacular event illustrating the value to mankind of the omnivorous habit of Gulls that enables them to turn to the food that is most abundant and thus to be ready to work where most needed, occurred many years ago in Utah, and has been described in many publications. At a critical time in the early settlement of the state by the

[6] Preble, *U. S. Biol. Surv., North Amer. Fauna No.* 27, 261, 1908.
[7] Anthony, *Auk*, XXIII, 131, 1906.
[8] Bent, *U. S. Natl. Mus., Bull.* 113, 3, 1921; citing Yarrell, *Hist. of Brit. Birds*, 1891.
[9] Strong, *Auk*, XXXI, 31-32, 1914.

Mormons, when black crickets had destroyed one crop and were again rapidly devastating the fields, threatening the pioneers with starvation, Gulls appeared by the thousands, cleared the fields of the insects and saved the crop. In 1913 the people of Utah, in grateful remembrance of what they considered an act of divine providence in their behalf, erected a beautiful monument to the Gulls at Salt Lake City, at an expense of $40,000.00.[10]

In 1923, 17-year locusts emerged in large numbers in Massachusetts and attacked the foliage. Gulls and Terns gathered in large flocks and fed voraciously on the insects, catching them on the wing.[11]

"During the vole outbreak in Scotland in 1892 several species of Gulls, notably the Great Black-backed Gull (*Larus marinus*), fed upon field mice; and Gulls are usually named among the species that feed upon lemmings during their migrations. It is highly probable that the larger American Gulls feed upon field mice whenever they find them." [12]

Many other instances of Gulls rushing to the repression of attacks of agricultural pests may be found in ornithological literature. Allen says that Gulls are "certainly among our most beneficial birds." [13]

Along the seashore, Gulls feed extensively upon clams, and have the habit, shared with Crows, of carrying the clams up and dropping them from a considerable height upon rocks in order to break the shells and get at the flesh. A photograph has been published showing where they have also been using a bridge for this purpose. Glaucous-winged and California Gulls (*Larus glaucescens* and *L. californicus*), have been seen

[10] Forbush, *Mass. Dept. Agric., Bull.* 9, frontispiece (a fine photograph), and p. 21, 1921; *Useful Birds and their Protection*, 65-67, 1907. Cannon, *Irrigation Age*, VII, 188-189, 1894. McAtee, *Ann. Rept. Smithsonian Inst. for* 1920, 415. McAtee and Beal, *U. S. Dept. Agric., Farmers' Bull.* 497, 21-22, 1912.

[11] Forbush, *Auk*, XLI, 468-470, 1924.

[12] Lantz, "An Economic Study of Field Mice," *U. S. Biol. Surv., Bull.* 31, 53, 1907. Piper, *U. S. Dept. Agric., Farmers' Bull.* 352, 21, 1909.

[13] Allen, "Birds in their Relation to Agriculture in New York State," *Cornell Reading Courses*, IV, No. 76, 34, 1914.

eating barnacles, while several gulls have been observed with starfishes in their beaks.[14]

The fish-eating habit of Gulls is well known, but has been grossly exaggerated. Some Gulls that are largely piscivorous in winter are quite insectivorous in summer when insects are abundant. Many of the fishes eaten by these birds are dead ones found floating on the surface. Others are species that occur in great schools upon which any possible depredations of birds can make but slight inroads, or species that are practically worthless as a source of human food, and some of them, such as the sticklebacks, are very harmful to food fishes, though they probably do some good locally in destroying certain aquatic insect larvæ. It has been estimated that the 4,000 Gulls about the Monterey Bay sardine canneries in California consume not to exceed $\frac{6}{10}$ of 1% as many sardines as the fishermen take and consequently can have no appreciable effect on the fisheries.[15] The live fishes they take are much more than offset by the good the birds do as scavengers, in cleaning up the harbor and disposing of the offal from the operations of the fishermen. Gulls have been called the "health officers of the coast, gleaning not only the refuse of shore and vessels, but of cities as well, when the seagoing garbage scows disgorge their loads." [16]

Four Herring Gulls (*Larus argentatus*) dissected by Baker all contained fish remains.[17] The Pacific Kittiwake (*Rissa tridactyla pollicaris*), Short-billed Gull (*Larus brachyrhynchus*), Laughing Gull (*L. atricilla*) and the Royal, Arctic and Sooty Terns (*Sterna maxima, fuscata* and *paradisaea*) have all been observed carrying fishes to their young, the fishes in case of the Arctic Tern, at least, being sticklebacks.[18] Most Gulls take fishes to at least some extent. On the other hand

[14] *Bird-Lore*, XVII, 451, 1915. Wales, *Condor*, XXVIII, 97, 1926. Swarth, *Condor*, XXVIII, 97-98, 1926.

[15] W. F. T., in *California Fish and Game*, VI, 85-86, 1920. Burrill, *ibid.*, V, 71-74, 1919.

[16] Wright, Nat. Assn. Aud. Soc., *Educ. Leaflet No.* 29, in *Bird-Lore*, IX, 277-278, 1907.

[17] Baker, *Proc. Acad. Nat. Sci. Phila. for* 1889, 266.

[18] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 433-434.

in destroying sea urchins they render a distinct service to the lobster fisheries and in feeding upon squids they are beneficial to the herring fisheries.[19] Two Laughing Gulls (*L. atricilla*) from Porto Rico contained fishes, 70%, and a crab.[20]

Gulls on their breeding ground, where they are nesting in proximity to large colonies of other birds, eat many eggs and even young of the other species, but it is doubtful whether this has done much harm, as the other species, in such cases, continue to exist in large numbers, notwithstanding the fact that the Gulls have been engaged in their depredations for many centuries. The species, nesting side by side, have developed their habits contemporaneously, and the destruction by the Gulls is offset by the normal overproduction of the other species, the "margin of safety" provided by Nature.

It has been said that the Franklin Gull (*Larus franklini*) is "the most beneficial of the group;" in 97 stomachs, vegetation 5.54%, of no value except wheat in two of them; grasshoppers, 43.43% for the year, ⅘ of whole diet for September and October; balance chiefly other insects; 1 contained 56 whole grasshoppers, jaws of 56 more, 3 crickets; another, 20 beetles, 66 crickets, 34 grasshoppers, 3 other insects; another, 90 grasshoppers, jaws of 52 more (think of 142 grasshoppers in a pile and the energy required to obtain them!), 8 crickets, etc.; another, 1,157 insects—82 beetles, 87 bugs, 984 ants, etc.; 1 was filled with dragonfly nymphs; several filled with grasshoppers and crickets too far advanced in digestion to be counted.[21] Several birds taken during nesting season contained only insects, chiefly dragonfly nymphs, 321 in 1 stomach.[22] One stomach contained numerous midges and 3 others

[19] Dutcher, *Auk*, XXI, 165, 1904.

[20] Wetmore, "Birds of Porto Rico," *U. S. Dept. Agric., Bull.* 326, 45, 1916.

[21] McAtee and Beal, *U. S. Dept. Agric., Farmers' Bull.* 497, 20-21, 1912. *U. S. Dept. Agric., Bull.* 513, 31, 1913.

[22] Roberts, *Auk*, XVII, 282, 1900. This reference is quoted by Bent, in his *Monograph on Grebes*, as applying to the American Eared Grebe, but it expressly refers to Franklin Gull, and is again quoted by Bent under the latter name in his later volume on *Gulls and Terns*. See Bent, *U. S. Natl. Mus., Bull.* 107, 32, 1919; *Bull.* 113, 170-171, 1921.

contained mostly locusts, with some dragonflies and other insects.[23]

In Utah it is common to see the California Gulls (*Larus californicus*) in flocks of from 200 to 300, following the plow or harrow in search of grubs, cutworms and other insects.[24] Not only do they render valuable aid in keeping insects in check, but in the alfalfa fields they have been observed to gorge themselves with mice, then to vomit up their victims and begin feeding again, thus destroying large numbers of those pernicious rodents.[25] One stomach contained remains of a Duck,[26] possibly a bird that had been killed or wounded by hunters.

Norton found Herring Gulls (*Larus argentatus*) feeding upon sea cucumbers, marine snails (including one active enemy of the soft-shelled clam), clams, crustaceans and the maggots that live on decaying seaweeds, and the Bonaparte (*L. philadelphia*) Gull feeding upon the maggots.[27] The maggot item is not to their credit, but other items are harmless and at least one or more useful. Six Herring Gulls "contained almost no fish remains, but all contained ants in varying quantities, only one being full."[28] Flocks of full-grown young of this species have been observed to eat "immense numbers of grasshoppers and Colorado [potato] beetles."[29] Of 44 stomachs taken in Scotland, 15 contained fishes; the others contained a brittle-star, crustaceans, insects, earthworms, grain and grass seeds.[30]

From Bent's Life Histories[31] the following items are culled, omitting garbage, carrion and waste food from ships, taken by most Gulls: Ivory Gull (*Pagophila alba*); "particularly

[23] Ferry, *Auk*, XXVII, 188, 1910.
[24] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 5-6, 1914.
[25] Dutcher, *Bird-Lore*, VII, 280, 1905.
[26] Fisher, *U. S. Biol. Surv., North American Fauna*, No. 7, 14, 1893.
[27] Norton, *Auk*, XXVI, 438-439, 1909.
[28] Dutcher, *Auk*, XXI, 164, 1904.
[29] Dutcher, *Auk*, XIX, 46, 1902.
[30] Burrill, "Is the Herring Gull Insectivorous?" *Calif. Fish and Game*, V, 71-74, 1919, citing Miss Laura Florence, in *Trans. Highland Agric. Soc. of Scotland*, 1912.
[31] Bent, *U. S. Natl. Museum, Bull*, 113, 1921.

fond of blubber of whales, walruses and seals," but takes any animal matter and on breeding grounds devours many lemmings. (p. 33.) Kittiwake (*Rissa tridactyla tridactyla*); lives largely on fishes, but takes other aquatic animals; drinks salt water and refuses fresh water. (pp. 39-40.) Pacific Kittiwake (*R. t. pollicaris*); in Alaska, feeds upon "the myriads of sticklebacks" (Nelson, 1887). (p. 47.) Glaucus Gull (*L. hyperboreus*); takes any animal matter, fresh or putrid, including fish, mollusks, starfishes, sea urchins, crustaceans, eggs and young of other birds and sometimes berries; great scavenger; 1 contained 2 Auks. (p. 57.) Iceland Gull (*L. leucopterus*); great scavenger; also feeds on berries. (p. 64.) Glaucus-winged Gull (*L. glaucescens*); "will eat anything that is edible"; great scavengers about salmon canneries. (p. 70.) Great Black-backed Gull (*L. marinus*); omnivorous; feeds largely on fishes and about breeding grounds takes eggs and young of other species. (pp. 82-83.) Slaty-backed Gull (*L. schistisagus*); feeds largely on dead fish, especially salmon. (p. 87.) Western Gull (*L. occidentalis*); primarily scavenger but also feeds largely on fish and on breeding grounds takes eggs and young of other species, sea urchins, rabbits, etc.; drinks salt water but does not like its food very salty. (p. 96.) British Lesser Black-backed Gull (*L. affinis*); fish, crustaceans, sea urchins, mollusks and earthworms are its habitual food; also eats young birds. (p. 101.) Herring Gull (*L. argentatus*); renders great service as scavenger in harbors and on beaches, but takes great variety of small animal life and follows the plow for grubs and other pests; sometimes robs nests of other species, but not so often as many other Gulls. (p. 112.) California Gull (*L. californicus*); "one of the most useful birds to the agriculturist of the western plains"; scavenger and also takes many mice, insects and other pests. (p. 129.) Ring-billed Gull (*L. delawarensis*); "as fully beneficial as any of the Gulls"; follows the plow for grubs and other pests, does effective work in feeding upon mice and other small rodents; some stomachs

were completely filled with grasshoppers; great scavengers; on breeding grounds feeds to some extent on eggs and young of other birds. (p. 137.) Short-billed Gull (*L. brachyrhynchus*); feeds largely on sticklebacks and other small fishes, sea urchins, carrion, etc.; 3 May stomachs contained water beetles.[32] (pp. 143-144.) Mew Gull (*L. canus*); feeds on small fishes, mollusks, crustaceans, carrion, etc., and visits the fields for worms and insect larvæ. (p. 147.) Heermann Gull (*L. heermanni*); feeds largely on fishes, crustaceans and other marine life and acts as scavenger along shores. (p. 151.) Laughing Gull (*L. atricilla*); food quite varied but largely fishes; some eggs of other birds; some garbage but not so much as some other Gulls. (pp. 160-161.) Franklin Gull (*L. franklini*); "almost wholly, if not entirely, beneficial to mankind." (pp. 170-171.) Bonaparte Gull (*L. philadelphia*); largely insectivorous in interior states; 2 were gorged with ants and insect larvæ; on seacoast they live on small fishes, crustaceans and other aquatic animals; very little vegetable matter. (pp. 177-178.) Little Gull (*L. minutus*); many stomachs taken early in the season contained insects, but chiefly fishes; probably more insectivorous later in season. (p. 181.) Ross Gull (*Rhodostethia rosea*); stomachs examined on breeding ground contained only insects. (p. 188.) Sabine Gull (*Xema sabini*); food is small fishes, aquatic insects, aquatic worms and crustaceans. (p. 194.)

From Aughey's report are obtained items summarized in the table on the opposite page, the "x" indicating items for which no definite amounts were given.[33]

Royal Tern (*Sterna maxima*); stomachs from Florida contained *"Squalius gibbosus,"* 1 containing 40 averaging 3 inches in length.[34] Three stomachs, Porto Rico; contained only fish remains.[35] Common Tern (*S. hirundo*); 3 stomachs, Porto

[32] See Preble, *U. S. Biol. Surv., N. Amer. Fauna* No. 27, 268, 1908.
[33] Aughey, 1st Rept. *U. S. Entom. Comm.*, App. II, 60-61, 1878.
[34] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 1889, 266.
[35] Wetmore, *U. S. Dept. Agric., Bull.* 326, 48, 1916.

Species of Birds	Number of stomachs	Grasshoppers and Locusts	Other insects	Crustaceans	Mollusks	Lizards	Fishes	Frogs
Herring Gull, *Larus argentatus*	2	13	..	..	..	..	x	..
Franklin Gull, *L. franklini*	10	210	111	x	x	..	x	x
Ring-billed Gull, *L. delawarensis*	6	36	14	x	x	..	x	x
Great Black-backed Gull, *L. marinus*	1	x	x	..	x	..	x	x
Least Tern, *Sterna antillarum*	8	72	135	x	x	..	x	x
Black Tern, *C. n. surinamensis*	6	228	90	x	x	x	..	x
Forster Tern, *Sterna forsteri*	2	17	..	x	..	x	x	..

Rico; contained 18 minnows.[36] Roseate Tern (*S. dougalli*); 2 stomachs, Porto Rico; contained only fish remains.[37] Bridled Tern (*S. anætheta*); 5 stomachs, Porto Rico; 1 empty; 4, fish remains, 70%, of no economic importance, including file fish; mollusks, 25%; a moth and an echinoderm, 5%.[38] Arctic Tern (*S. paradisæa*); seen carrying large numbers of skeleton shrimps to its young.[39] Sooty Tern (*S. fuscata*) and Noddy (*Anous stolidus*); appear to feed almost entirely on small fishes[40] and waste from ships.[41] One Noddy stomach contained an entire flying fish and remains of others.[42] Three stomachs, Porto Rico; 1 empty; 1 contained squid jaws; 1 contained 3 fishes.[43]

McAtee and Beal have furnished data on the stomach contents of various species of Terns, from which the following items are gleaned:[44] Royal Tern (*S. maxima*); 24 stomachs; crustaceans, 3%; fishes, 97%, including perch, bluefish, menhaden and others, not over 16% being commercial fishes. Forster's Tern (*S. forsteri*); 34 stomachs; crustaceans, 2%;

[36] Wetmore, *ibid.*, 48.
[37] Wetmore, *ibid.*, 47.
[38] Wetmore, *ibid.*, 46.
[39] Norton, *Auk*, XVI, 439, 1909.
[40] Watson, *Carnegie Inst. Wash., Pub.* 103, 193, 1908.
[41] Bent, *U. S. Natl. Museum, Bull.* 113, 284-285, 1921.
[42] Bowdish, *Auk*, XIX, 358, 1902.
[43] Wetmore, *Bull.* 326, *supra*, 46.
[44] McAtee and Beal, *U. S. Dept. Agric., Farmers' Bull.* 497, 22-26, 1916.

fishes, 98%, including, among others, menhaden, silvery anchovies (noncommercial), minnows, pompanos, round herrings and sticklebacks. Common Tern (*S. hirundo*); 116 stomachs; mollusks, crustaceans and worms that feed upon oysters (*Nereis*), 1%; moths, 2%; other insects, 1.5%; fishes, 95.5%, largely fresh-water minnows and lances, only 6% food fishes, 85% fishes of neutral importance, 4.3% sticklebacks, which are said to be very destructive to the young of other fishes. Least Tern (*S. antillarum*); 49 stomachs; crustaceans, 5%; fishes, 95%, no food fishes detected. Black Tern (*Chlidonias nigra surinamensis*); 145 stomachs; dragonflies, 20%; May flies, 13%; grasshoppers, 12%; predaceous diving beetles, 6%; scarabid beetles, 5%; many other insects; crustaceans 3.5%; fishes, 19%, chiefly minnows and *Fundulus*, of very little value to man; some of the insects taken are enemies of fishes. The average of food fishes in the contents of all the stomachs of the 5 species is said to be only 4.8%, the fish items consisting chiefly of species enormously abundant and used only as fertilizer or for the extraction of their oil and scarcely affected by the small numbers taken by the Terns.

Additional Tern items from Bent's Life Histories are briefly summarized, as follows:[45] Gull-billed Tern (*Gelochelidon nilotica*); mainly insectivorous; Audubon found several stomachs "crammed with a mass of" spiders, but never found other food in them, except insects, though Yarrell says they also take frogs, crabs and fish. (pp. 200-201.) Caspian Tern (*S. caspia*); food mainly fishes; also takes crustaceans; in Minnesota, during migration, feeds on fresh-water mussels; said to eat eggs and young of other birds, an unusual habit for a Tern. (p. 209.) Elegant Tern (*S. elegans*, p. 219); Trudeau Tern (*S. trudeaui*, pp. 227-229), and Aleutian Tern (*S. aleutica*, p. 268); food habits little known. Cabot Tern (*S. sandvicensis acuflavida*); food almost wholly small fishes (mullets, sand lances and young garfish), but also eats shrimps and squids. (p. 225.) Arctic Tern (*S. paradisæa*); food chiefly

[45] Bent, *U. S. Natl. Museum, Bull.* 113, 1921.

small fishes such as capelin and sand lances, but also takes crustaceans. (p. 253.) Roseate Tern (*S. dougalli*); food almost wholly small fishes, especially sand lances, 80%. (pp. 262-263.) Least Tern (*Sterna antillarum*); 75 summer stomachs; contained almost exclusively fishes, only 4 or 5 containing any insects. (p. 277.) Black Tern (*Chlidonias nigra surinamensis*); stomachs from Massachusetts contained only small fishes, no insects; in the interior states almost wholly insectivorous. (pp. 295-297.) White-winged Black Tern (*C. leucoptera*); feeds chiefly on aquatic insects and worms, seldom on fishes. (p. 301.)

Because of their beautiful plumage some of the members of this family of birds have been much sought by the millinery trade. Many thousands of Gull skins have found their way into the markets of the world. Whole colonies of the Least Tern were almost exterminated for their plumage along the Atlantic about 30 years ago. On Cable Island 10,000 were killed in a single season, a slaughter personally conducted by a woman.[46] One gunner marketed 3,000 Terns from Long Island in 1883; 2 men contracted in Florida for delivery of 30,000 of them in one season, and 40,000 were killed at Cape Cod, according to reports.[47] As recently as 1905 eggs of Gulls were sold in the markets of Lake Michigan ports, and it was reported that egg poachers sometimes carried away from the breeding colonies of the Herring Gull in Delta County, from 2,000 to 3,000 eggs on a single trip.[48]

Family Rhynchopidæ. *Skimmers*

The Black Skimmer (*Rhyncops nigra*) has a highly specialized bill, the lower mandible projecting far beyond the end of the upper one, a characteristic generally supposed to be an adaptation to a habit of skimming the surface of the water for

[46] Pearson, "Least Tern" (Natl. Assn. Aud. Soc., Leaflet No. 97), *Bird-Lore*, XX, 380-383, 1918.
[47] Palmer, *Yearbook U. S. Dept. Agric. for* 1899, 272-274.
[48] Barrows, *Michigan Bird Life*, 54, 1912; citing Van Winkle.

its food, consisting of small fishes. The bird is also said to use its bill for prying open bivalve mollusks. The "skimming" of food had been questioned, but, however common or uncommon it may be, it has been actually observed to do so by competent and trustworthy ornithologists.[49] However, the fact that it lives largely upon small fishes, mostly worthless, does not seem to be in dispute, but it takes also crustaceans. Stomachs examined by the United States Biological Survey were empty.[50]

[49] Compare Arthur, *Auk*, XXXVII, 566-574, 1921, and Stone, *Auk*, XXXVII, 595-596, 1921.

[50] Bent, *U. S. Natl. Museum, Bull.* 113, 316-317, 1921.

ORDER TUBINARES. TUBE-NOSED SWIMMERS

Family Diomedeidæ. *Albatrosses*

The Albatrosses are voracious feeders, but are maritime birds and consequently of slight economic importance. Their throats are capable of great expansion, enabling them, it is said, to swallow pieces of whale blubber weighing 3 or 4 pounds.[1] They are omnivorous, feeding upon anything edible from the surface of the sea, including garbage from ships' galleys, dead animals, living marine invertebrates and small vertebrates. The Short-tailed and Laysan Albatrosses (*Phoebastria albatrus* and *P. immutabilis*) feed largely on squids, while the Black-footed Albatross (*P. nigripes*) is said to feed extensively upon "a pelagic crab."[2]

Family Hydrobatidæ. *Fulmars, Shearwaters and Petrels*

These are also maritime birds and accept all sorts of animal matter found floating on the sea, including carrion, garbage from ships and fishermen's boats, etc., with a decided preference for oily substances, such as whale blubber, but take also living marine animals, especially invertebrates. One stomach of a Slender-billed Fulmar (*Priocella antarctica*) contained oil and cuttlefish. The Giant Fulmar (*Macronectes giganteus*), the "vulture of the seas," lives chiefly upon carrion, and one in captivity declined fish even after it had been deprived of other food for several days. When it died its mate fed upon its carcass.[3] Stomachs of the Pacific Fulmar (*Fulmarus glacialis*

[1] Belding, *Condor*, V, 17, 1902.
[2] Bent, "Life Histories of North American Petrels and Pelicans and their Allies," *U. S. Natl. Museum, Bull.* 121, 3, 8, 15, 1922.
[3] Bent, *U. S. Natl. Museum, Bull.* 121, 28-29, 34-36, 40-41, 45-46, 48, 1922.

glupischa) from the California coast contained no fishes but were often filled with a slimy mass of jellyfishes and small crustaceans,[4] though it is not unlikely that they do take fishes, as many stomachs of the closely related Atlantic form (*F. glacialis glacialis*) contained almost exclusively small fishes.[5]

The food of most species of Petrels does not appear to have been much studied, but those that have been studied are so much alike in their feeding habits that probably the conclusions would in a general way, at least, apply to all. They accept refuse from ships and fishermen's boats and any oily or fatty substances from the surface of the ocean. Many stomachs are found to be filled with oil, possibly derived from small crustaceans, which are often also contained in the stomachs. Some species, at least, are said to feed to a slight extent upon seaweeds, and on mollusks, fish eggs and comb jellyfishes.[6]

Shearwaters, like the other birds of this family, are scavengers, taking scraps of food thrown from ships, refuse from the cleaning of fish about fisheries, etc. They also eat small fishes, crustaceans, squids and sometimes marine plants.[7] One stomach of the Greater Shearwater (*Ardenna gravis*) contained 24 beaks of squids.[8] Collins examined hundreds of stomachs of the Sooty Shearwater (*Puffinus griseus*) and never failed to find squid remains in them, though they also take fishes and doubtless other food.[9] Anthony found many Black-vented Shearwaters (*P. opisthomelos*) gorged with herring.[10]

[4] Anthony, *Auk*, XII, 104, 1895.
[5] Collins, *Osprey*, IV, 35, 1899; cited by Bent, *U. S. Nat. Museum, Bull.* 121, 35, 1922.
[6] Bent, *U. S. Natl. Museum, Bull.* 121, 51-52, 122, 127-128, 134-135, 142-143, 157, 162-165, 168-169, 175, 179, 1922.
[7] Bent, *ibid.*, 58, 64, 67-68, 73, 82, 87, 95, 99.
[8] Bent, *ibid.*, 68.
[9] Collins, *Rept. U. S. Commissioner of Fish and Fisheries for* 1882, 311, 1884; quoted by Bent, *U. S. Natl. Museum, Bull.* 12, 87, 1922.
[10] Anthony, *Auk*, XIII, 226, 1896.

ORDER STEGANOPODES. TOTI-PALMATE SWIMMERS

These birds are chiefly of maritime habit, though Cormorants and Pelicans visit inland waters and the Water Turkey is found regularly about the fresh waters of southeastern United States. They have little economic significance, except perhaps very locally.

Family PHAËTHONTIDÆ. *Tropic-birds*

Yellow-billed Tropic-bird (*Leptophaëthon lepturus catesbyi*); 5 stomachs; contained mostly squids and 5 species of small fishes, including 2 species of flying fishes; 1 contained a crab and sea urchin; young birds during the first 10 to 15 days feed chiefly on snails and soft-bodied marine animals; from 15 to 30 days, 90% squids, balance small minnows; later almost entirely fish, with a few squids.[1] Two stomachs from Porto Rico; 1 empty; 1 contained fish bones.[2] Food as a whole chiefly marine animals.[3]

Red-billed Tropic-bird (*Phaëthon æthereus*); food in stomachs examined consisted chiefly of fish and squids.[4] Red-tailed Tropic-bird (*Scœophaëthon rubricaudus*); 1 stomach; contained beaks of a cuttlefish.[5]

Family SULIDÆ. *Gannets and Boobies*

Booby (*Sula leucogastra*); Porto Rican stomachs examined contained only fish remains.[6] Chapman says the young are

[1] Gross, *Auk*, XXIX, 49, 1912.
[2] Wetmore, *U. S. Dept. Agric., Bull.* 326, 18, 1916.
[3] Bent, "Life Histories of North American Petrels and Pelicans and their Allies," *U. S. Natl. Museum, Bull.* 121, 185, 1922.
[4] Bent, *ibid.*, 189. [5] Bent, *ibid.*, 193.
[6] Wetmore, *U. S. Dept. Agric., Bull.* 326, 19, 1916.

fed on squids and fishes, but on another page quotes Audubon to the effect that they are fed on flying fish and mullets.[7]

According to Bent, the Blue-footed Booby (*Sula nebouxi*) and Gannet (*Moris bassanus*) feed principally, if not wholly, on fish; the favorite food of the Blue-faced Booby (*Sula dactylatra*) is flying fish; the Common Booby (*S. leucogastra*) feeds chiefly on flying fish and mullet, though 5 species of fish were found in 1 stomach; and the food of the Red-footed Booby (*S. piscator*) consists of various fishes and squids.[8]

Family Anhingidæ. *Darters*

Water Turkey (*Anhinga anhinga*); food consists chiefly of fishes; young birds are fed chiefly on suckers, pickerel and a few small catfish, none of much value.[9] Five stomachs; 3 males each contained a 14-inch fish; 2 females full of small fishes.[10] Audubon found in stomachs examined by him various kinds of fishes, aquatic insects, crustaceans, leeches, amphibians, young alligators, snakes and terrapins; 1 in captivity swallowed 9 fishes each about 7½ inches long, in succession.[11]

Family Phalacrocoracidæ. *Cormorants*

Though Cormorants feed very extensively on fishes, the species taken are mostly small, non-commercial forms, and species that are very abundant. It is very doubtful whether these birds have any appreciable effect upon the supply of food and game fishes.

The Double-crested Cormorant (*Phalacrocorax auritus auritus*) has been often accused by fishermen of being detrimental to the salmon fisheries. Taverner's investigations

[7] Chapman, *Carnegie Inst. Wash.*, Pub. No. 103, 144, 147, 1908.
[8] Bent, *U. S. Natl. Museum, Bull.* 121, 196, 200, 206-211, 214, 225, 1922.
[9] Baynard, *Wilson Bull.*, XXIV, 169, 1912.
[10] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 266, 1889.
[11] Quoted in Bent, *U. S. Natl. Museum, Bull.* 121, 233-234, 1922.

show the accusation to be unfounded, and that the "total effect of bird enemies upon salmon is small, if any"; 32 stomachs; 5 empty; contents of 3 unrecognizable; there were sculpins in 16, herring in 5, capelin in 1, eel in 1, tomcod in 2.[12] In Rhode Island it was found feeding chiefly on eels, 1 stomach containing an eel 16 inches long.[13]

Florida Cormorant (*P. auritus floridanus*); 6 stomachs; all contained *"Squalius gibbosus."*[14] The young are fed largely on eels, and 1 immature bird disgorged a large water snake.[15] Red-faced Cormorant (*P. urile*) feeds its young on small fishes and crustaceans, according to Nelson.[16] Bent says that the Common, Pelagic, Brandt and Mexican Cormorants (*P. carbo, P. pelagicus pelagicus, P. penicillatus* and *P. vigua mexicanus*) feed chiefly or wholly on fish,[17] and likely this is true of other species.

Farallon Cormorant (*P. auritus albociliatus*); young birds disgorged chiefly smelt, surf-fish and sardines. Said to do no harm, as the large colony at Martin Island, Lower California, consumes about 400 tons of fish daily from the neighboring water (and this has doubtless been going on for centuries), yet the fish are still abundant in that locality and always hungry,[18] indicating that they are about as abundant as their food supply will permit. Indeed, it may even be that the birds are beneficial to the fishes in this instance, by preventing overabundance, which would reduce the food supply for fishes and thus in the end be injurious to them.

[12] Taverner, "Birds of Eastern Canada," Canada Dept. of Mines, *Museum Bull.* 13, 1-24, 1919. Quoted at considerable length in *California Fish and Game*, II, 198-199, 1916, and more briefly in *Wilson Bull.*, XXVII, No. 92, 410-411, 1915, and Bent, *U. S. Natl. Museum, Bull.* 121, 248-249, 1922.

[13] Mackay, *Auk*, XI, 18, 1894.

[14] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 266, 1899.

[15] Pearson, Brimley and Brimley, "Birds of North Carolina," North Carolina Geol. Surv., IV, 49, 1919.

[16] Quoted in Judd, *Yearbook U. S. Dept. Agric. for* 1900, 434.

[17] Bent, *U. S. Natl. Museum, Bull.* 121, 239, 248-249, 254, 257-265, 269, 274, 1922.

[18] Wright, *Condor*, XV, 207, 1913.

Family Pelecanidæ. *Pelicans*

These birds feed to a great extent on fishes and are generally but probably erroneously supposed to be injurious to the fisheries. A few years ago a very enlightening series of letters on this subject appeared in Bird-Lore, to which the reader is referred.[19]

Brown Pelican (*Pelecanus occidentalis occidentalis*); 1 stomach, Porto Rico; contained only fishes of small species that are so abundant that those taken by Pelicans are negligible.[20] Stomachs examined in Florida all contained *"Squalius gibbosus"*; 1 contained 3 fishes averaging 14 inches in length; 1 contained 5 averaging nearly 7 inches; 1 contained 75 averaging 3 inches; 1 contained 2 averaging 11 inches.[21] Thorough investigation of large colonies in Louisiana proved that their food there consists almost wholly of menhaden, a small, bony fish, not generally considered a food fish by human beings, but occurring in large schools and used as a fertilizer; no food fishes found in the stomachs examined.[22] Bent says this species feeds entirely on fish, chiefly menhaden, mullet and other species unfit for human food, and adds: "Complaints that it is very destructive to food fish . . . have been proven as not well founded by an exhaustive investigation conducted by the Department of Conservation in Louisiana, in coöperation with the [United States] Biological Survey."[23] California Brown Pelican (*P. occidentalis californicus*); feeds chiefly, but not wholly, on fish, and around the Galapagos Islands acts as a scavenger.[24]

American White Pelican (*P. erythrorhynchos*); feeds chiefly on fish, even larger ones, such as trout, bass, chub, carp, catfish, suckers, pickerel and pike; Audubon found several hun-

[19] *Bird-Lore*, XX, 194-198, 1918.
[20] Wetmore, *U. S. Dept. Agric., Bull.* 326, 18, 1916.
[21] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[22] Bailey, *Wilson Bull.*, XXX, No. 104, 65-68; 1918.
[23] Bent, "Life Histories of North American Petrels and Pelicans and their Allies," *U. S. Natl. Museum, Bull.* 121, 299, 1922.
[24] Bent, *ibid.*, 304.

dred small fish in one stomach; Maynard says a captive bird ate 6 or 8 pounds of fish at a meal.[25] Ferry observed young birds disgorging chiefly salamanders, with some sticklebacks and other non-food fishes.[26] Nebraska stomachs all contained from 21 to 67 insects, with some crayfish, frog and fish remains.[27]

Family Fregatidæ. *Man-o'-war-birds*

Man-o'-war-bird (*Fregata magnificens rothchildi*); feeds largely on fish, but takes jellyfish, mollusks and other food.[28] One stomach contained a flying fish.[29]

[25] Bent, *ibid.*, 287.
[26] Ferry, *Auk*, XXVII, 187, 1910.
[27] Aughey, 1st Rept. *U. S. Entom. Comm.*, 1878.
[28] Bent, *U. S. Natl. Museum, Bull.* 121, 311, 1922.
[29] Chapman, *Carnegie Inst. Wash., Pub.* 103, 145, 150, 1908.

ORDER ANSERES. LAMELLIROSTRAL SWIMMERS

Family Anatidæ. *Ducks, Geese and Swans*

Wild Ducks, Geese and Swans are almost altogether harmless, though there does seem to be some good evidence that locally they have at times done some harm to rice and other grain fields.[1] On the other hand, the board of directors of the Arkansas Rice Growers Coöperative Association estimated that Ducks have saved the rice growers of that state $150,000 annually by the destruction of seeds of red rice (a serious pest) that have been buried in the mud of the rice fields.[2] Ducks are also known to destroy many mosquitoes. Ten Mallards were placed in a pond where mosquito larvæ were abundant and in 48 hours the larvæ were practically all gone.[3] New Jersey industriously killed mosquito-eating Ducks and Shorebirds for the market for years, and has since spent $3,500,000 in one year in fighting mosquitoes.[4]

Furthermore, Ducks provide recreation for an army of sportsmen, more, perhaps than all other birds. However, merely as a source of food they cannot under present conditions be deemed of great importance, for the reason that probably the cost of obtaining them on the whole far exceeds their food value.

Most species of Ducks whose usual habitat is the fresh waters of the interior feed to a great extent on aquatic vege-

[1] For example, see *California Fish and Game*, IV, 30, 38, 39, 70, 72, 1918.

[2] McAtee, *Auk*, XL, 527-528, 1923.

[3] Dixon (Health Commissioner of Pennsylvania), *Journ. Amer. Medical Assn.*, LXIII, 1203, 1924. Quoted by McAtee, *U. S. Dept. Agric., Bull.* 720, 9, 1918, and by Forbush and others.

[4] Forbush, *Mass. State Dept. Agric., Bull.* 9, 57-58, 1921.

tation, but take various forms of animal life, such as insects, crustaceans and mollusks. Their bills and tongues are well adapted to straining food from water and mud, while the species addicted to a fish diet have bills and tongues quite different in shape and structure, adapted to catching and firmly holding their slippery prey. Geese and Swans have tongues adapted to their habit of pulling up aquatic plants for food.[5]

During grasshopper outbreaks Ducks have been found with from 200 to 250 grasshoppers in their stomachs; young Mallards have been seen "stuffing themselves with Mayflies"; young Wood Ducks were caught feeding on Mayflies and locusts; one Duck in Louisiana contained 72,000 seeds, and a young Mallard was filled with grasshoppers.[6] At Great Salt Lake brine shrimps and alkali fly larvæ and pupæ are devoured in immense numbers by various species of Ducks.[7] The items referring to the species of this family, in Aughey's report on the birds of Nebraska in relation to insects, are briefly summarized in the table on the following page.[8]

In response to a general demand on the part of sportsmen, state game commissioners and others, the United States Biological Survey has conducted extensive and minute investigations of the food and feeding habits of wild Ducks and Geese, the results of which have been embodied in several important bulletins.[9] The United States National Museum has also pub-

[5] See Gardner, "The Adaptive Modifications and the Taxonomic Value of the Tongues of Birds," *Proc. U. S. Natl. Museum*, LXVII, 1-19, 1925, and authorities therein cited.

[6] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 435. Fisher, *North American Fauna*, No. 7, 15, 1893. *U. S. Dept. Agric., Farmers' Bull.* 513, 5. Bryant, *Univ. Calif. Pub. Zool.*, XI, No. 1, 12-13.

[7] Wetmore, *U. S. Dept. Agric., Bull.* 936, 15, 1921; citing *Amer. Nat.*, LI, 753-755, 1917.

[8] Aughey, 1st Rept. *U. S. Entom. Com.*, 1878.

[9] McAtee, "Five Important Wild-duck Foods," *U. S. Dept. Agric., Bull.* 58, 1914; "Eleven Important Wild-duck Foods," *Bull.* 205, 1915; both superseded by "Propagation of Wild-duck Foods," *Bull.* 465, 1917; "Food Habits of Mallard Ducks in the United States," *Bull.* 720, 1918; "Wild-duck Foods of the Sandhill region of Nebraska," *Bull.* 794, 37-76, 1920. Mabbott, "Food Habits of Seven Species of Shoal-Water Ducks," *Bull.* 862, 1920. Wetmore, "Wild Ducks and Duck Foods of the Bear River Marshes," *Bull.* 936, 1921.

Species of Birds	Number of stomachs	Locusts (average number)	Other insects (average number)	Mollusks	Vegetation (seeds, etc.)
Mallard, Anas platyrhynchos . . .	10	22	26	x	..
Black Duck, Anas rubripes	1	16	30	..	x
Green-winged Teal, Nettion carolinense	9	5	38	x	
Blue-winged Teal, Querquedula discors	1	37	22	x	x
Pintail, Dafila acuta tzitzihoa . . .	7	11	34	x	..
Wood Duck, Aix sponsa	9	15	23	x	..
Bufflehead, Charitonetta albeola . .	4	10	22	..	..
Ruddy Duck, Erismatura jamaicensis	1	31	20	x	..
Snow Goose, Chen hyperboreus hyperboreus	8	30	33	x	x
Canada Goose, Branta canadensis canadensis	9	31	42	x	x

lished two bulletins on life histories of North American wild fowl, which contain a large amount of information on food habits.[10] Other recent publications have dealt with the great mortality among Ducks about certain lakes in Utah, Nevada and California, which has been attributed to alkali poisoning, and with lead poisoning from swallowing expended shot found in the mud of their feeding grounds in shallow water frequented by hunters.[11]

From the great mass of detailed and minutely analyzed information in Mabbott's and McAtee's reports on the food habits of 10 species of American Ducks,[12] the most important

[10] Bent, "Life Histories of North American Wild Fowl, Order Anseres," *U. S. Natl. Museum*, Pt. 1, *Bull.* 126, 1923; Pt. 2, *Bull.* 130, 1925.

[11] Wetmore, "Mortality among Waterfowl Around Great Salt Lake, Utah," *U. S. Dept. Agric., Bull.* 217, 1915; "The Duck Sickness in Utah," *Bull.* 672, 1918; "Lead Poisoning in Waterfowl," *Bull.* 793, 1919. Clarke, *Condor*, XV, 214-226, 1913.

[12] Mabbott, *U. S. Dept. Agric., Bull.* 862, 1920 (Gadwall, Baldpate, Pintail, Wood Duck and Teals). McAtee, *U. S. Dept. Agric., Bull.* 720, 1918 (Mallard and Black Ducks).

items have been selected and condensed into the following table of percentages, the "x" being used to indicate instances in which certain food was found in stomachs of Ducks but no amounts are given:

Kinds of Food	Gadwall Chaulelasmus streperus	Baldpate Mareca americana	Blue-winged Teal Querquedula discors	Cinnamon Teal Querquedula cyanoptera	Green-winged Teal Nettion carolinense	Wood Duck Aix sponsa	Pintail Dafila acuta tzitzihoa	Mallard Anas platyrhynchos	Black Duck Anas rubripes	Florida and Mottled Ducks Anas fulvigula and variety maculosa
Number of Stomachs	417	255	219	41	653	413	790	1578	622	51
Total animal matter	2.15	6.77	29.47	20.14	9.33	9.81	12.85	9.47	24.09	40.50
Insects	0.55	0.42	10.41	10.19	4.57	6.39	2.85	2.31	x	9.00
Spiders and mites	..	..	..	..	..	0.63	..	..	..	..
Mollusks	1.60	6.25	16.82	8.69	3.59	..	5.81	5.73	12.27	27.00
Crustaceans	..	0.10	1.93	..	0.92	0.08	3.79	0.35	7.99	2.77
Fishes and fish eggs	..	..	..	..	..	..	..	..	1.34	2.57
Miscellaneous	..	..	0.31	1.26	0.25	2.71	0.40	0.72	..	..
Total Vegetable matter	97.85	93.23	70.53	79.86	90.67	90.19	87.15	90.53	75.91	59.50
Grasses	7.59	13.09	12.26	7.75	11.00	8.17	9.64	13.39	11.00	50.00
Sedges	19.91	7.41	18.79	34.27	38.82	9.14	21.78	21.62	11.00	6.31
Duckweeds	0.61	2.20	..	..	1.90	10.35	0.80	6.01	..	..
Pondweeds	42.33	42.82	12.60	27.12	11.52	6.53	28.04	8.23	32.24	x
Smartweeds, etc.	0.59	1.47	8.22	3.22	5.25	4.74	4.74	9.83	5.00	9.54
Waterlily Family	0.52	0.26	1.37	..	..	5.95	2.57	..	..	x
Water Milfoils	..	3.48	0.71	0.37	1.11	..	0.21	..	..	..
Algae	10.40	7.71	2.95	..	4.63	..	3.44	..	..	..
Wild Celery, etc.	0.53	5.75	..	..	..	..	..	3.54	..	..
Arrowheads	3.25	..	..	..	..	..	x	3.54	..	..
Arrowgrass	..	0.36	..	..	0.91	..	4.52	..	..	..
Coontail	7.82	0.24	..	..	..	2.86	..	5.97	..	x
Grains (rice, etc.)	1.31	..	0.98	..	..	..	..	..	..	..
Madder	0.37	..	0.35	..	..	..	..	..	..	..
Mallows	..	..	..	1.87	..	..	..	..	..	..
Goosefoot Family	..	..	..	0.75	..	..	2.58	..	..	..
Bur Reeds	..	..	0.38	0.85	..	..	..	..	3.37	..
Cypress cones, etc.	..	..	..	..	9.25	..	..	..	..	..
Acorns and Beechnuts	..	..	..	..	..	6.28	..	2.34	..	..
Waterelms, etc.	..	..	..	..	..	4.75	..	4.11	..	..
Water Plantain	..	..	..	..	..	..	x	..	..	..
Primrose Willow	..	..	..	..	..	..	..	x	..	..
Miscellaneous	2.61	7.63	11.92	4.51	14.68	22.17	5.99	..	x	x

Items culled from McAtee's report[13] on 3 important Duck foods are here presented in tabular form as follows:

[13] McAtee, "Three Important Wild Duck Foods," *U. S. Biol. Surv., Circular* 81, 1911.

Species of birds	Number of stomachs	Wild rice	Wild celery	Pond-weeds	Total of the three
		Percentages			
Mallard, Anas platyrhynchos	209	17.13	2.48	12.67	32.28
Black Duck, Anas rubripes	51	12.05	2.37	8.35	32.77
Gadwall, Chaulelasmus streperus	37	....	....	17.64	17.64
Baldpate, Mareca americana	30	7.16	10.00	13.71	30.87
Green-winged Teal, Nettion carolinense	126	4.56	.69	10.32	15.57
Blue-winged Teal, Querquedula discors	86	3.46	.20	9.83	13.49
Shoveller, Spatula clypeata	49	....	....	7.83	7.83
Pintail, Dafila acuta tzitzihoa	67	4.95	1.80	13.39	20.14
Wood Duck, Aix sponsa	75	11.62	3.17	6.72	21.51
Redhead, Marila americana	60	4.41	11.71	24.38	40.50
Canvas-back, Marila valisineria	60	.33	23.71	42.35	66.39
Scaup, Marila marila	67	1.26	14.46	23.20	38.92
Lesser Scaup, Marila affinis	126	7.49	17.53	8.18	33.20
Goldeneye, Clangula clangula americana	23	....	2.95	6.56	9.51
Bufflehead, Charitoneta albeola	36	2.22	5.66	4.46	12.34
Ruddy Duck, Erismatura jamaicensis	41	....	9.54	12.56	22.10
Average for all species	....	4.78	6.65	13.88	25.31

McAtee's discussion of the propagation of Wild Duck foods yields the following important items concerning the percentages of certain plants in the food of certain Ducks: [14] Wild rice (*Zizania*), 17% in 209 Mallard stomachs, 12% in 51 Black Ducks, 11% in 75 Wood Ducks. (p. 4.) Pondweeds (*Potamogeton*), from 60% to 80% of food of Canvasbacks at a lake in Wisconsin. (pp. 13-14.) Delta potato (*Sagittaria*), Louisiana, 70% of food of Canvasbacks. (p. 21.) Chufa, a sedge (*Cyperus esculentus*), Arkansas, 56% of food of 9 Mallards. (p. 28.) Wild millet (*Echinochloa crus-galli*), Louisiana, from 10% to 75% of food of Mallards at various localities. (p. 32.) Watershield, of the waterlily family (*Brasenia schreberi*), found in 19 species of Ducks and true waterlilies in 13 species. (p. 35.) Banana waterlily (*Castalia mexicana*), Texas, 48% of total food of all Ducks (Canvasback, 71.6%; Ring-necked Duck, 91%; Black Ducks, 98%).

The Mergansers feed to a great extent on fishes and are easily distinguished from river Ducks by their bills, modified

[14] McAtee, "Propagation of Wild-duck Foods," *U. S. Dept. Agric., Bull.* 465, 1917.

to enable them to hold slippery fishes.[15] American Merganser (*Mergus merganser americanus*); 1 contained 13 perch, some nearly 3 inches long; Audubon found fishes 7 inches long in some, and reports very rapid digestion, a captive bird devouring over 2 dozen fish about 4 inches long 4 times daily; on Maine coast, eats many mussels and other mollusks; also takes some amphibians, crustaceans, leeches, worms, aquatic insects and aquatic plants.[16] One California stomach contained 5 carp about 4 inches long; individuals on breeding ponds have been found gorged with trout.[17] Red-breasted Merganser (*Mergus serrator*); 1 stomach; 9 rock bass and a shark, each 2 to 4 inches long.[18] Chiefly a fish eater, but takes also crustaceans, insects, mollusks, worms, amphibians and other food.[19] Hooded Merganser (*Lophodytes cucullatus*); food largely insects, but takes small fish, frogs, mollusks and some aquatic plants, seeds and grain.[20] One contained 12 tiny fishes, another 20.[21] Smew (*Mergellus albellus*); food chiefly small fish, crustaceans, frogs, aquatic insects and mollusks.[22]

Domestic Ducks have been frequently known to render efficient aid in keeping insects in check. During an outbreak of grasshoppers in California, they fed largely on these insects, each taking 300 or 400 daily, from 200 to 250 being found in some stomachs, representing a single meal.[23]

Mallard (*Anas*[24] *platyrhynchos*); on Pacific coast feeds largely on dead salmon and salmon eggs; where available, they take also nuts, insects, including mosquito larvæ, snails, frogs and lizards.[25] One stomach contained 75,200 seeds of

[15] Allen, *Cornell Reading Courses*, IV, No. 76, 34, 1914. Haynes, *Wilson Bull.* No. 34, XIII, 10-11, 1901.
[16] Bent, *U. S. Natl. Museum, Bull.* 126, 8-9, 1923.
[17] Grinnell, Bryant and Storer, *Game Birds of California*, 83, 1918.
[18] Linton, *Condor*, X, 126, 1908.
[19] Bent, *ibid.*, 18. Strong, *Auk*, XXIX, 484-485, 1912.
[20] Bent, *ibid.*, 27.
[21] Judd, *U. S. Biol. Surv., Bull.* 17, 53, 1902.
[22] Bent, *Bull.* 126, supra, 32-33.
[23] Bryant, *Univ. Calif. Pub. in Zoöl.*, XI, No. 1, 12-13, 1912.
[24] For other data on this genus, see preceding tables.
[25] Bent, *U. S. Dept. Agric., Bull.* 126, 41-43, 1923.

sedges, primrose willow and duckweed, and 1 contained 102,400 seeds of primrose willow.[26] A downy young bird was found with stomach distended with grasshoppers.[27] California stomachs contained small snails, seeds and half cupful of barley.[28]

Black Duck (*Anas rubripes*); eats aquatic insects, amphibians, crustaceans, leeches, worms, mollusks, seeds, roots, grain, nuts and sometimes even small mammals; sometimes gorged with huckleberries.[29] One contained 23,704 weed seeds and a few snails (pigweed, 13,240 seeds; knot grass, 7,264; ragweed, 2,624; dock, 576).[30] Stomachs, 29; 4 empty; food in others, vegetable matter 88.4% (seeds of burreed, pondweed, bulrush, eelgrass, mermaid weed and wild celery); animal matter, 11.6% (mollusks, ants and other insects and crustaceans).[31] One contained 36,300 smartweed seeds.[32] In Maine in winter they were found feeding chiefly on marine snails (*Littorina*), but one was gorged with fresh-water snails (*Campeloma*) and 2 gullets were filled with eelgrass and a few crustaceans.[33] Florida Duck (*Anas fulvigula fulvigula*); 2 contained small marine mollusks.[34] New Mexico Duck (*Anas novimexicana*); food consists of cattails, alfalfa, grass roots, corn, wheat, fresh-water mollusks and seeds.[35]

European Widgeon (*Mareca penelope*); food, roots of eelgrass (*Zostera*), when available; on coasts under strictly marine conditions they "live entirely on small cockles"; in spring they are great grass eaters and later devour enormous quantities of flies.[36] Five stomachs taken in America contained chiefly widgeon grass, eelgrass, pondweeds, dodder and bul-

[26] McAtee, *U. S. Dept. Agric., Bull.* 720, 3, 1918.
[27] Fisher, *North American Fauna*, No. 7, 15, 1893.
[28] Grinnell, Bryant and Storer, *Game Birds of California*, 99, 1918; quoting Bryant, *Zoe*, IV, 55, 1893.
[29] Bent, *Bull.* 126, supra, 57-58.
[30] Eaton, "Birds of New York," *N. Y. State Museum, Mem.* 12, Pt. 1, 186, 1909.
[31] Phillips, *Auk*, XXVIII, 199, 1911.
[32] McAtee, *U. S. Dept. Agric., Bull.* 720, 10-14, 1918.
[33] Norton, *Auk*, XXVI, 439, 1909.
[34] Baker, *Proc. Acad. Natl. Sci. Phila.*, XLI, 267, 1889.
[35] Huber, in Bent, *U. S. Natl. Museum, Bull.* 126, 49, 1923.
[36] Bent, *U. S. Natl. Museum, Bull.* 126, 87, 1923.

rush.[37] Baldpate (*M. americana*)[38]; food mainly seeds and roots of grasses and water plants; Audubon says it eats beechnuts, leeches and small fishes; in Pennsylvania Warren found 2 that had "fed entirely on insects"; Baker dissected a large number containing small snails (*Truncatella*) and seeds.[39] Phillips' report that the Widgeon on a Massachusetts lake was entirely vegetarian, stomachs containing pondweed, wild celery, waterlily, burreed and smartweed, with 65% mineral matter,[40] is attributed by Bent to the Baldpate. Seventeen stomachs from Klamath Lake, Oregon; in 13, snails 100%.[41] One examined by Judd contained only wild rice sprouts and aquatic plant stems.[42]

European Teal (*Nettion creca*); feeds on aquatic plants, insects, mollusks and worms. The Green-winged Teal (*Nettion carolinense*), about the canneries of the Northwest, feeds upon salmon carrion.[43] Otherwise, its habits are clean, as may be seen by reference to tables on preceding pages. Blue-winged and Cinnamon Teals (*Querquedula discors* and *Q. cyanoptera*); food well shown in tables on preceding pages. It may be added that the former takes some grain in the fields in autumn. Twenty Florida stomachs contained small aquatic mollusks (*Amnicola and Truncatella*).[44]

Ruddy Sheldrake (*Casarca ferruginea*); food, aquatic plants, insects, worms, and fish fry and roe.[45] Sheld Duck (*Tadorna tadorna*); on Lincolnshire coast, lives on mollusks and crustaceans; 10 stomachs, Belfast Bay; 1 contained 20,000 mollusks; takes also a little vegetation and occasionally insects.[46]

Shoveller (*Spatula clypeata*); food, various kinds of aquatic

[37] Mabbott, *U. S. Dept. Agric., Bull.* 862, 16-17, 1920.
[38] See also tables on preceding pages.
[39] Bent, *U. S. Natl. Museum, Bull.* 126, 92-94, 1923.
[40] Phillips, *Auk*, XXVIII, 199, 1911.
[41] Mabbott, *U. S. Dept. Agric., Bull.* 862, 15, 1920.
[42] Judd, *U. S. Biol. Surv., Bull.* 17, 81, 1902.
[43] Bent, *U. S. Natl. Museum, Bull.* 126, 100-101, 106-107, 1923.
[44] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[45] Bent, *U. S. Natl. Museum, Bull.* 126, 131, 1923.
[46] Bent, *ibid.*, 133-134.

vegetation, small fishes, amphibians, crustaceans, leeches, aquatic worms, mollusks and aquatic insects.[47] Bill highly specialized for sifting food from mud and water, but only 15% to 20% of the birds examined by McAtee had been feeding on bottom ooze; 84 stomachs; vegetable matter, 65.7% (sedges, 16.02; pondweeds, 11.25; grasses, 8.28; algæ, 6.55; waterlilies, 2.5; duckweeds, 1.7; smartweeds, 1.1); animal matter, 34.97% (fresh-water mollusks, 18.97; aquatic insects next in importance; small fishes, 3%).[48] Ten Florida stomachs all contained mollusks, especially *Rissoina*.[49] Owens Lake, California; found feeding on pupæ and larvæ of a fly (*Ephydra*).[50]

American Pintail (*Dafila acuta tzitzihoa*); stomach analyses given in a table on a preceding page. Food, chiefly aquatic plants, with some minnows, crustaceans, leeches, worms, mollusks, insects and even amphibians and mice.[51] Stomachs examined by Baker contained mollusks.[52] Bahama Pintail (*Poecilonetta bahamensis*); 8 adult stomachs, Porto Rico; no animal matter; ditch-grass seed, 16.25%; algæ (*Chara*), 83.75%; 2 downy young stomachs; insects and snails, 3.5%; foxtail, barnyard and guinea grass seed, 94%; other seeds, 2.5%.[53]

Wood Duck (*Aix sponsa*); see food table on a preceding page; vanishing over most of its range.[54] Food largely insects, but some small fishes, amphibians and mollusks; during autumn and winter, largely vegetable food in great variety, including wild fruits and nuts; Nuttall reports a stomach filled with Coleoptera.[55] On Maine coast, shows preference for arrowhead bulbs.[56] Two California stomachs contained a large number of acorns.[57]

[47] Bent, *ibid.*, 140-141. [48] McAtee, *Auk*, XXXIX, 380-386, 1922.
[49] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[50] Fisher, *North American Fauna*, No. 7, 17, 1893.
[51] Bent, *U. S. Natl. Museum, Bull.* 126, 150-151, 1923.
[52] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[53] Wetmore, *U. S. Dept. Agric., Bull.* 326, 29, 1916.
[54] Fisher, *Yearbook U. S. Dept. Agric. for* 1901, 454-458.
[55] Bent, *U. S. Natl. Museum, Bull.* 126, 166-167, 1923.
[56] Norton, *Auk*, XXVI, 439, 1909.
[57] Grinnell, Bryant and Storer, *Game Birds of California*, 144, 1918.

Tufted Duck (*Fuligula fuligula*); food, duckweed and other plants, insects and amphibians; Bavarian stomachs contained fish spawn, frogs, mussels, insects and aquatic plant seeds.[58] Rufous-crested Duck (*Netta rufina*); food, aquatic plants.[59] European Pochard (*Aithyia ferina*); food in summer and autumn chiefly aquatic plants and fresh-water mollusks, with some amphibians and fishes; in summer, the young eat many insects, but adults not many.[60]

Redhead (*Marila*[61] *americana*); food, aquatic plants, insects, amphibians, small fishes, lizards, acorns, beechnuts, mollusks, etc.[62] Canvasback (*M. valisineria*); Atlantic coast, principal food, celery, with some amphibians, fishes, leeches and mollusks.[63] One stomach contained 100 bulrush seeds.[64] On Pacific coast it takes more animal food, especially crustaceans and mollusks; several California stomachs contained marine clams and snails; one contained grass, and one was filled with barley.[65] Stomachs from British Columbia were filled with fresh-water snails, one containing 200 *Valvatas*.[66] Scaup (*M. marila*); in summer home on fresh water, lives on fish fry, small fishes, amphibians, mollusks, insects and some aquatic vegetation; in winter, on seacoast, lives on crustaceans, starfishes, mollusks and considerable aquatic vegetation.[67] One Maine stomach was filled with marine clams.[68] Autumn stomachs, Massachusetts; aquatic vegetation and bivalve mollusks in equal proportions.[69] Lesser Scaup (*M. affinis*); fish fry and spawn, tadpoles, aquatic mollusks, worms, crayfish, aquatic insects and a variety of aquatic plants.[70]

[58] Bent, *U. S. Natl. Museum, Bull.* 126, 204, 1923.
[59] Bent, *ibid.*, 174.
[60] Bent, *ibid.*, 187.
[61] For this genus see also table on a preceding page.
[62] Bent, *ibid.*, 180-181.
[63] Bent, *ibid.*, 195-196.
[64] Judd, *U. S. Biol. Surv., Bull.* 17, 81, 1902.
[65] Grinnell, Bryant and Storer, *The Game Birds of California*, 154, 1918.
[66] Hanham, *The Nautilus*, XXVIII, 88, 1914.
[67] Bent, *U. S. Natl. Museum, Bull.* 126, 211-212, 1923.
[68] Norton, *Auk*, XXVI, 439, 1909.
[69] Phillips, *Auk*, XXVIII, 199, 1911.
[70] Bent, *U. S. Natl. Museum, Bull.* 126, 221, 1923.

One stomach contained a crab claw and 75 aquatic snails.[71] Eight Florida stomachs all contained mollusks, especially *Rissoina*.[72] One stomach, Porto Rico; dragonfly larvæ, 69%; seeds, 4%; fragments of beetles, etc.[73] Massachusetts stomachs contained burreed, bayberry and sawgrass.[74] Ring-necked Duck (*M. collaris*); food, aquatic plants, small fish, amphibians, crustaceans, mollusks, insects and even grains.[75]

American Goldeneye (*Glaucionetta clangula americana*); on coasts, feeds largely on small mussels and other mollusks, with some eelgrass; on Pacific coast, found feeding on mussels, crabs, marine worms and decaying salmon; inland, takes small fishes, tadpoles and insects, but lives largely on great variety of aquatic plants, such as teal moss, flags, duckweed, pondweed, water plantain, bladderwort, etc.[76] A Massachusetts stomach contained seeds of pondweed, waterlily, bayberry and burreed, buds and roots of wild celery and a few insects.[77] Maine stomachs contained seeds of eelgrass and marine snails (*Lacuna* and *Margarita*).[78] One California stomach contained only clams (*Mya arenaria*).[79] Barrow Goldeneye (*G. islandica*); food similar to that of American Goldeneye.[80]

Bufflehead (*Charitonetta albeola*); on seacoast, food is crustaceans and bivalve mollusks; on fresh waters, crustaceans, snails, leeches and grasses (Audubon); other writers include insects; vegetation in only small quantities, mainly in summer; in inland Maine, small fishes (Knight).[81]

Old Squaw (*Clangula hyemalis*); food mostly mollusks, some crustaceans, insects and vegetation, but, on breeding grounds, largely aquatic vegetation, such as teal moss, blue

[71] Judd, *U. S. Biol. Surv., Bull.* 17, 81, 1902.
[72] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[73] Wetmore, *U. S. Dept. Agric., Bull.* 326, 28-29, 1916.
[74] Phillips, *Auk*, XXVIII, 199, 1911.
[75] Bent, *U. S. Natl. Museum, Bull.* 126, 227-228, 1923.
[76] Bent, *U. S. Natl. Museum, Bull.* 130, 7-8, 1925.
[77] Phillips, *Auk*, XXVIII, 200, 1911.
[78] Norton, *Auk*, XXVI, 439, 1909.
[79] Grinnell, Bryant and Storer, *Game Birds of California*, 173, 1918.
[80] Bent, *U. S. Natl. Museum, Bull.* 130, 19-20, 1925.
[81] Bent, *ibid.*, 28. See also table on a preceding page.

flag, duckweed, water plantain, pondweed and pickerel weed.[82] In New England, food said to be mostly mollusks, crustaceans, fishes and pondgrass.[83] In Ohio, takes many angleworms, etc.[84] At Chicago, food almost entirely minnows; 1 said to have contained about 140 fishes averaging about 2 inches long.[85]

Atlantic Harlequin Duck (*Histrionicus histrionicus histrionicus*); on inland waters, feeds largely on insects (caddis-fly prominent); also fish spawn, small fishes, frogs, crustaceans, mollusks and some aquatic plants; on seacoast, similar marine animals, chiefly black mussels.[86] One stomach, Long Island; crabs and other crustaceans and marine snails (*Columbella* and *Littorina*).[87]

Labrador Duck (*Camptorhynchus labradorius*); has been extinct for quite a number of years. Audubon said its food was shellfish, fish fry and various aquatic plants.[88]

The Eiders are valuable on account of their down, which is very light and a poor conductor of heat; hence they have been much persecuted on the Atlantic coast of America. In Norway and Iceland they are rigidly protected and the Eider farms afford a large income.[89]

King Eider (*Somateria spectabilis*); on fresh-water breeding grounds, food chiefly plants, but stomachs contain many insects; downy young contain crustaceans and plant material; at other seasons a seabird, food mainly crustaceans, starfishes, sea cucumbers, small fishes and spawn.[90] Two Maine stomachs filled with crustaceans.[91] One contained a marine snail, mussels (*Mytilus*) and a crab.[92] American

[82] Bent, *ibid.*, 43, 1925.
[83] Mackay, *Auk*, IX, 333, 1892.
[84] Haynes, *Wilson Bull.*, No. 32, new ser., VII, 12-13, 1900.
[85] Hull, *Wilson Bull.*, No. 88, 119, 1914. See also *Oölogist*, XXXI, 199, 1914.
[86] Bent, *U. S. Natl. Museum, Bull.* 130, 55, 1925.
[87] Whitfield, *Auk*, XI, 323, 1894.
[88] Quoted in Bent, *U. S. Natl. Museum, Bull.* 130, 62-67, 1925.
[89] Townsend, "A Plea for the Conservation of the Eider," *Auk*, XXXI, 14-21, 1914. Bent, *U. S. Natl. Museum, Bull.* 130, 94-95, 1925.
[90] Bent, *ibid.*, 114. [91] Norton, *Auk*, XXVI, 438-440, 1909.
[92] Whitfield, *Auk*, XI, 323, 1894.

Eider (*S. mollissima dresseri*); favorite food marine mussels, but takes other mollusks, crustaceans, echinoderms and worms.[93] One stomach contained remains of 5 crabs.[94] Northern Eider (*S. m. borealis*); powerful gizzard; almost any marine animal acceptable; mussels favorite; 1 contained a 10-inch razor-clam shell; another, 43 mollusks, some 2 inches long; 20 gizzards examined contained many mollusks, some crustaceans, fragments of ophiurian and algæ, and a few fish bones.[95]

Steller Eider (*Polysticta stelleri*); in August feeds largely on marine invertebrates, especially worms; in winter, on Kodiak Island, feeds chiefly on crustaceans; also takes fish spawn and small fishes, possibly plants. Spectacled Eider (*Arctonetta fischeri*); summer food, small crustaceans, grass, seeds, and such other food as brackish-water pools afford.

White-winged Scoter (*Oidemia deglandi*); food varied; on New England coast, chiefly black mussels and other mollusks; stomachs found "crammed full of mollusks" nearly an inch long; on inland waters, live largely on crayfish and mollusks, with some insects; on western sloughs, feed largely on aquatic plants (flags, duckweed, pondweed, pickerel weed, etc.).[96] Nine stomachs, Massachusetts; mussels, 44%; clams, 22%; periwinkles, 19%; hermit crabs, 9%; balance caddis larvæ, algæ, etc.[97] One California stomach contained 4 species of marine snails; another, a sand dollar (echinoid).[98] American Scoter (*O. americana*); on interior waters, feeds on small fishes and spawn, mollusks, crayfish, amphibians and various plants (duckweed, pondweed, flags, water milfoil, bladderwort, etc.).[99] On fresh waters it prefers fresh-water mussels (Unionidæ); 13 Massachusetts stomachs; mussels, 95%; balance starfish and periwinkles.[100] Also takes marine clams

[93] Mackay, *Auk*, VII, 315-319, 1890. Bent, *U. S. Natl. Museum, Bull.* 130, 100, 1925.
[94] Whitfield, *Auk*, XI, 323, 1894.
[95] Bent, *ibid.*, 87-89.
[96] Bent, *ibid.*, p. 135.
[97] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 162, 1912.
[98] Grinnell, Bryant and Storer, *Game Birds of California*, 200, 1918.
[99] Bent, *ibid.*, 123-124.
[100] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 159, 1912.

(*Spisula*), scallops and razor-shell clams.[101] Velvet Scoter (*O. fusca*); food chiefly mollusks and crustaceans; some stomachs filled with common marine mussels; in Orkney, partial to razor clams.[102] Surf Scoter (*O. perspicillata*); food about same as other Scoters, mostly small, black mussels; some crustaceans and fish spawn, a little vegetation, such as eelgrass and algæ; some stomachs "crammed full of small shellfish."[103] One contained 900 marine snails (*Margarites*). Nine stomachs; mussels, 79.6%; periwinkles, 13.8%; algæ and eelgrass, 6.6%.[104]

Ruddy Duck (*Erismatura jamaicensis*); for stomach analyses see table on a preceding page. Food largely grasses and various aquatic plants, with some small fishes and spawn, mollusks, worms and insects.[105] One Connecticut stomach; 22,000 pondweed seeds.[106] Six Massachusetts stomachs; vegetable matter, 40%; animal matter, 60%; seeds of many species of aquatic plants with insect larvæ.[107] A California stomach contained seeds of ditch-grass and some algæ; others contained finely ground vegetable matter.[108]

The species of Geese and Swans vary less in their food habits than do Ducks, and their food at different localities varies less. Most of the species feed chiefly on plants.

Snow Goose (*Chen hyperboreus hyperboreus*); food largely vegetable, almost wholly so in winter home; in spring, sprouting grain and grass; in autumn, grain from stubble fields, berries, insects and probably other invertebrates.[109] One California stomach; 1,581 barley grains; another, 500 stalks of "filaree"; in California feeds largely on grass; in the north in summer, rushes, berries and insects.[110] Greater Snow Goose

[101] Mackay, *Auk*, VIII, 280, 1891.
[102] Bent, *U. S. Natl. Museum, Bull.* 130, 129, 1925.
[103] Bent, *ibid.*, 148.
[104] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 165, 1912.
[105] Bent, *U. S. Natl. Museum, Bull.* 130, 157-158, 1925.
[106] Barrows, *Michigan Bird Life*, 109, 1912.
[107] Phillips, *Auk*, XXVIII, 199-200, 1911.
[108] Grinnell, Bryant and Storer, *Game Birds of California*, 209, 1918.
[109] Bent, *U. S. Natl. Museum, Bull.* 130, 166-167, 1925.
[110] Grinnell, Bryant and Storer, *Game Birds of California*, 213, 1918.

(*Chen hyperboreus nivalis*); food much like that of Snow Goose; less opportunity for feeding in stubble; New Jersey and Delaware coast, feeds on marine plants, especially "sea cabbage."[111] Blue Goose (*C. cærulescens*); stomachs examined by U. S. Biological Survey, contents wholly spikerush; in Louisiana feeds also on "duck potato."[112] On Mississippi delta feeds on roots of various grasses and cattails; injury to pastures so great 2,000 acres abandoned.[113]

White-fronted Goose (*Anser albifrons albifrons*); Alaska stomachs, only animal food aquatic insects; food chiefly young grass shoots; in far north feeds largely on berries; California, in winter grain from stubble fields and in spring young shoots of grain; Audubon found snails in gizzards, but no fishes or salamanders.[114] "Responsible for considerable damage to grain."[115] Bean Goose (*A. fabalis*); partial to all sorts of grain; also eats grass and clover.[116]

Canada Goose (*Branta canadensis canadensis*); food varies with habitat and season; spring migration overland, considerable damage to sprouting grain; farther north, preceding year's wild berries; later, insects, crustaceans, mollusks and probably small fishes; autumn migration, grain from stubble fields; in marshes, many species of grasses and aquatic plants.[117] Maine stomachs contained eelgrass and sea lettuce (*Ulva lactuca*).[118] Hutchins Goose (*B. canadensis hutchinsi*); food similar to that of Canada Goose, though Nuttall says on coasts they feed mostly on marine plants and mollusks.[119] One California stomach, 1,147 barley grains; another, 1,076; where abundant, damages freshly planted fields.[120] Brant (*B. bernicla bernicla*); on breeding grounds, food is "grass,

[111] Bent, *U. S. Natl. Museum, Bull.* 130, 177, 1925.
[112] Bent, *ibid.*, 181-182.
[113] McAtee, *Auk*, XXVII, 337-339, 1910.
[114] Bent, *U. S. Natl. Museum, Bull.* 130, 192, 1925.
[115] Grinnell, Bryant and Storer, *Game Birds of California*, 221, 1918.
[116] Bent, *U. S. Natl. Museum, Bull.* 130, 199, 1925.
[117] Bent, *ibid.*, 212-213.
[118] Norton, *Auk*, XXVI, 439, 1909.
[119] Bent, *ibid.*, 224.
[120] Grinnell, Bryant and Storer, *Game Birds of California*, 232, 1918.

algæ, roots and stalks, and leaves of Arctic plants"; on United States coasts, algæ, crustaceans, mollusks, worms and marine insects; Heligoland, mollusks and crustaceans; in captivity, fond of barley and will eat other grains; in Baffin Land in spring seen feeding on rock lichens.[121] Maine stomachs contained eelgrass.[122] Black Brant (*B. nigricans*); maritime; west coast, feeds chiefly on marine plants; especially fond of eelgrass; some mollusks, crustaceans and other marine animals.[123] Barnacle Goose (*B. leucopsis*); fond of both vegetable and animal matter.[124] Emperor Goose (*Philacta canagica*); Stewart and St. Michael Islands; food, shell-fish; at times resorts to berries.[125]

Black-bellied Tree Duck (*Dendrocygna autumnalis*); "Cornfield Duck"; feeds on corn in the fields and does some damage. Fulvous Tree Duck (*D. bicolor*); said to feed on alfalfa, acorns, grasses and weeds.[126] One California stomach contained finely cut grass and other vegetation.[127]

Whooping Swan (*Cygnus cygnus*); chiefly aquatic plants but also takes mollusks and worms. Whistling Swan (*C. columbianus*); largely aquatic vegetation, with some grain, seeds, worms, insects, amphibians and even fish; in Montana found feeding on fresh-water snails.[128] One Oregon stomach, 20 mollusks; sometimes destructive to grain.[129] One Maryland stomach contained 1 bulrush seed and a small mass of wild celery.[130] Trumpeter Swan (*C. buccinator*); a vanishing race; Audubon says food is vegetation, aquatic insects, snails, reptiles, etc.[131]

[121] Bent, *U. S. Natl. Museum, Bull.* 130, 243-244, 1925.
[122] Norton, *Auk*, XXVI, 439, 1909.
[123] Bent, *ibid.*, p. 253. Grinnell, Bryant and Storer, *Game Birds of California*, 240, 1918, citing Bryant, *Zoe*, IV, 55, 1893.
[124] Bent, *ibid.*, 261-262.
[125] Bent, *ibid.*, 266.
[126] Bent, *ibid.*, 271-276.
[127] Grinnell, Bryant and Storer, *Game Birds of California*, 250, 1918.
[128] Bent, *U. S. Natl. Museum, Bull.* 130, 279, 286, 1925.
[129] Grinnell, Bryant and Storer, *Game Birds of California*, 261, 1918.
[130] Judd, *U. S. Biol. Surv., Bull.* 17, 81, 1902.
[131] Bent, *U. S. Natl. Museum, Bull.* 130, 298, 1925.

ORDER ODONTOGLOSSÆ. FLAMINGOES

Family PHŒNICOPTERIDÆ. *Flamingoes*

These interesting birds, with long necks and legs, have peculiarly shaped bills, quite different from those of herons, enabling them to scoop their food from the mud. Stomachs examined by Chapman all contained only marine snails (*Cerithium*).[1]

[1] Chapman, *Bull. Amer. Museum Nat. Hist.*, XXI, 67, 1905.

ORDER HERODIONES. HERONS, STORKS, BITTERNS AND IBISES

The members of this order, especially the Great Blue Heron, have been much persecuted because of a widespread but mistaken belief that their food consists almost entirely of fishes and that they are very destructive to food and game fishes. The fishes they take are of very little food value, though they do take them in quantity when they are available and easily obtained. For example, a Night Heron shot at a carp pond contained heads of 78 carp.[1-2] On the other hand, however, they feed very largely upon amphibians and snakes, including poisonous ones, and do a very large amount of good as "persistent enemies of meadow mice," gophers and other rodents, as well as in the destruction of crayfish, which are injurious to the levees of the South and destructive to fish spawn there and elsewhere.[3] The harm the Herons do is more than offset by the good.

The more important items concerning the food of Herons and Ibises, in Baynard's report, are herein condensed and presented in tabular form, the food of adults being determined by examination of stomachs, that of the nestlings from food disgorged at the nest after being fed by the parents, the snakes being mostly moccasins and the fishes mostly catfish and suckers.[4]

[1-2] Smiley, *Bien. Rept. Fish Com. Colorado for* 1884

[3] Lantz, "An Economic Study of Field Mice," *U. S. Biol. Surv., Bull.* 31, 52-53, 1907; *Yearbook U. S. Dept. Agric. for* 1900, 217. Judd, *Yearbook U. S. Dept. Agric. for* 1900, 435. Baynard, "Food of Herons and Ibises," *Wilson Bull.*, new series, XIX, 167-169, 1912.

[4] Baynard, *Wilson Bull.*, n. ser., XIX, 167-169, 1912.

	Snakes	Lizards	Frogs	Fishes	Crayfish	Dragonflies	Cutworms	Grasshoppers
Louisiana Heron, 1 adult	..	..	..	..	..	..	..	200
Louisiana Heron Nestlings, 50 meals	..	6	8	..	67	..	17	2,876
Little Blue Heron, 1 adult	1	..	2	..	3	..	3	51
Little Blue Heron Nestlings, 50 meals	..	8	37	..	142	..	147	1,900
Green Heron, 1 adult	..	..	3	..	6	..	2	16
Night Heron, nestlings, 50 meals	..	..	..	641	60	79	..	..
Snowy Egret, nestlings, 50 meals	7	2	..	120	29	..	91	762
Egret, nestlings, 50 meals	47	..	297	61	176	..	..	..
Glossy Ibis, 1 adult	1	..	..	..	19	..	14	12
White Ibis, nestlings, 50 meals	42	..	..	..	602	..	352	308

Family Plataleidæ. *Spoonbills*

Spoonbills are known in Australia as very active agents in the suppression of locust incursions.[5]

Family Threskiornithidæ. *Ibises*

The Ibises are praised by Lantz as destroyers of field mice,[6] and in Australia they have played an important rôle in suppressing locust outbreaks.[7]

White Ibis and Glossy Ibis (*Gaura alba* and *Plegadis falcinellus*); feed chiefly upon crayfish (which are destructive to fish spawn), cutworms, grasshoppers and other insects, and young moccasins; 1 Glossy Ibis contained 14 cutworms, 12 grasshoppers, 19 crayfish, part of a moccasin and a bug; half the food of young over 3 weeks old is moccasins; 194 meals of 4 birds from 7 to 30 days old consisted of 412 cutworms (all prior to 17th day), 1967 grasshoppers, 1391 crayfish, 147 snakes.[8] White-faced Glossy Ibis (*Plegadis gau-*

[5] Riley and Howard, *Insect Life*, IV, 409, 1891-2. Forbush, *Useful Birds and their Protection*, 65, 1907.
[6] Lantz, *U. S. Biol. Surv., Bull.* 31, 52, 1907.
[7] Riley and Howard, *Insect Life*, IV, 409, 1891-2. Forbush, *Useful Birds and their Protection*, 65, 1907.
[8] Baynard, *Wilson Bull.*, n. ser., XIX, 167-169, 1912; XX, 109, 114-115, 1913.

rauna); 1 California stomach; full of aquatic plants and a beetle.[9]

Family Ciconiidæ. *Storks and Wood Ibises*

The stork is an enemy of field mice and helps reduce plagues of mice.[10] Wood Ibis (*Mycteria americana*); 1 California bird; crop filled with aquatic insects; 3 stomachs contained tadpoles, insects, worthless fishes, moss and slime; 1 stomach, 12 seeds of mesquite and screw bean, 4 water beetles and finely ground vegetable matter.[11]

Family Ardeidæ. *Herons, Egrets and Bitterns*

American Bittern (*Botaurus lentiginosus*); Barrows has taken from its stomach fish, frogs, mice, snakes, snails and a great variety of aquatic insects. Norton in Maine found in stomachs frogs, field mice and water beetles. In Florida Baker found their food to be chiefly frogs and toads. One Nebraska stomach contained 16 grasshoppers. Three Porto Rico stomachs; fish, 84.34%, of little value; crustaceans, 13.33%; amphibian, 0.33%; insects (Hemiptera) 2%.[12]

Great Blue Heron (*Ardea herodias herodias*); "especially valuable in destroying pocket gophers; many California ranchers protect this bird on their lands; its excellent work in killing field mice entitles it to protection everywhere."[13] Food mainly fish and frogs, according to Barrows, but also eats "immense numbers" of crayfish, with snakes, salamanders, insects, meadow mice and almost anything of animal nature,

[9] Grinnell, Bryant and Storer, *Game Birds of California*, 273, 1918.
[10] Lantz, *U. S. Biol. Surv., Bull.* 31, 52-53, 1907.
[11] Daggett, *Condor*, V, 18-19, 1902. Grinnell, Bryant and Storer, *Game Birds of California*, 269, 1918. Bryant, *Condor*, XXI, 236-237, 1919.
[12] Barrows, *Michigan Bird Life*, 127, 1912. Norton, *Auk*, XXVI, 439, 1909. Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889. Aughey, 1st Rept. *U. S. Entom. Com.*, 55, 1878. Wetmore, *U. S. Dept. Agric., Bull.* 326, 26-27, 1916.
[13] Lantz, "Pocket Gophers as Enemies of Trees," *Yearbook U. S. Dept. Agric. for* 1909, 217.

but no vegetation.[14] Known in Louisiana as the "crayfish bird" because of its food habits, according to Judd.[15] In Florida its food is said to consist of snakes, amphibians and worthless fishes.[16] One California stomach, 2 gophers only.[17] One from Nebraska, 11 locusts, with fishes and frogs.[18] West Indian Blue Heron (*A. h. adoxa*); in Porto Rico found feeding on small fish and crabs.[19]

Green Heron (*Butorides virescens virescens*); feeds extensively on fish; 1 of 2 stomachs contained also a spider, a water bug and 20 dragonflies.[20] One from Connecticut was filled principally with salt-marsh minnows, but also an eel, insects and spiders, while 1 from New York was filled with grasshoppers.[21] One from California, animal matter 100% (grasshoppers, 15%).[22] Two from Porto Rico contained fish, lizards, insects, crustaceans and worms.[23] Its food in Florida is said to consist of amphibians, snakes and worthless fish.[24] Four nestlings examined by the United States Biological Survey contained fish, crayfish and aquatic insects.[25] Cuban Green Heron (*B. v. cubanus*); 51 stomachs, Porto Rico, December to August; vegetable matter, 0.82%; animal matter, 99.18% (destructive mole crickets, 53.33; other Orthoptera, 5.92; dragonfly larvæ, 3.84; fishes only 9.5 and only in 16 birds; crustaceans, 14.71; lizards, 1.15; amphibians, 0.61; miscellaneous, 2.37).[26]

Little Blue Heron (*Florida cærulea*); feeds extensively on fish, according to Judd, who gives no further information.[27] Baker says that in Florida its food consists of amphibians,

[14] Barrows, *Michigan Bird Life*, 136, 1912.
[15] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 435.
[16] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[17] Bryant, *Univ. Calif. Pub. Zool.*, VI, No. 1, 9, 1912.
[18] Aughey, 1st Rept. *U. S. Entom. Com.*, 55, 1878.
[19] Wetmore, *U. S. Dept. Agric., Bull.* 326, 26, 1916.
[20] Judd, *U. S. Biol. Surv., Bull.* 17, 81, 1902.
[21] Barrows, *Michigan Bird Life*, 145, 1912.
[22] Bryant, *Univ. Calif. Pub. Zool.*, VI, No. 1, 9, 1912.
[23] Bowdish, *Auk*, XIX, 359, 1902.
[24] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[25] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 435.
[26] Wetmore, *U. S. Dept. Agric., Bull.* 326, 22, 1916.
[27] Judd, *U. S. Biol. Surv., Bull.* 17, 81, 1902.

snakes and worthless fishes.[28] One stomach, Louisiana; 51 grasshoppers, 2 frogs, 3 cutworms, 1 lizard, 3 crayfish.[29] Fifteen stomachs, Porto Rico, February, March, May, June, August; vegetable matter, 2.78%; animal matter, 97.22% (insects, 38.74, including destructive mole crickets, 7.23; crustaceans, 27.4; lizards, 29.44; 21 small lizards in 1, a goby in another, the only fish mentioned).[30]

Louisiana Heron (*Hydranassa tricolor ruficollis*); 1 stomach, Porto Rico; 16 fishes 1 to 2 inches long (killifishes except 1 goby, of little value).[31] One stomach, Louisiana; contained only digested grasshoppers, "evidently about 200."[32] Baker says in Florida it subsists on amphibians, snakes and worthless fishes.[33]

Yellow-crowned Night Heron (*Nyctanassa violacea*); stomachs contained fish, crustaceans and worms.[34] Black-crowned Night Heron (*Nycticorax nycticorax nævius*); 100 regurgitations, 80% fish, chiefly whiting, herring and cunners, the whiting found dead on beach; balance miscellaneous animal matter (marine worms, crustaceans, insects and mollusks); young birds, 3 to 10 days old, 16 out of 20 regurgitations chiefly shrimps; after 3 weeks, food chiefly fish; 1, 25 days old, fish 90%; at Atwood, Illinois, food chiefly amphibians.[35] Ten adult and 10 nestling stomachs contained only fish; in another heronry, young were fed pout, pickerel and herring.[36] In New Mexico they were found feeding on dead salamanders.[37] In Florida this and the Yellow-crowned Night Heron are said to live on amphibians, snakes and worthless fishes.[38] The Black-crowned is known also to eat algæ.[39]

[28] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[29] Baynard, *Wilson, Bull.*, n. ser., XIX, 168, 1912.
[30] Wetmore, *U. S. Dept. Agric., Bull.* 326, 23-24, 1916.
[31] Wetmore, *ibid.*, 24-25.
[32] Baynard, *Wilson Bull.*, n. ser., XIX, 168, 1912.
[33] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[34] Bowdish, *Auk*, XIX, 359, 1902. [35] Gross, *Auk*, XL, 19-22, 1923.
[36] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 435, citing Endicott, *Amer. Nat.*, I, 344, 1867. [37] Wetmore, *Auk*, XXXVII, 394, 1920.
[38] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 267, 1889.
[39] Latham, *Bird-Lore*, XVI, 112, 1914. DeKay, *Zool. N. Y.*, 1844, as cited by Gross, *supra.*

The Egrets have been much persecuted and over a large part of their range all but exterminated by the feather trade, because of their "fatal nuptial garments." Snowy Egret (*Egretta candidissima candidissima*); 2 stomachs, Porto Rico; vegetable matter, 1%; 1 contained 2 dragonfly nymphs, a crab, a lizard and a frog; the other was filled with bones of goby, a fish of little value, with some flies and grasshoppers, but when they visit the fields their food is doubtless more largely insects.[40] In Louisiana it is known as the "crayfish bird," because of its food habit there.[41] Egret (*Herodias egretta*); 1 stomach, Porto Rico; vegetable rubbish, 4%; a small goby and 7 frogs, 60%; Orthoptera, 15% (1 mole cricket and 7 grasshoppers).[42]

[40] Wetmore, *U. S. Dept. Agric.*, Bull. 326, 25, 1916.
[41] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 435.
[42] Wetmore, *U. S. Dept. Agric., Bull.* 326, 25-26, 1916.

ORDER PALUDICOLÆ. CRANES, RAILS, ETC.

The following items concerning this order have been culled from Aughey's report on Nebraska birds [1] and tabulated:

	Number of stomachs	Locusts and Grasshoppers Average number	Other insects Average number	Mollusks	Vegetation (seeds, etc.)
Sandhill Crane, Grus mexicana	4	66	50	..	x
King Rail, Rallus elegans	7	33	30	..	x
Black Rail, Creciscus jamaicensis	1	11	27	..	x
Florida Gallinule, Gallinula chloropus cochinnans	1	7	29	..	x
Coot, Fulica americana	9	33	39	x	x

Family GRUIDÆ. *Cranes*

Cranes inhabit both upland and lowland, hence have a rather varied diet. They are mentioned by many writers as enemies of grasshoppers and locusts, and also destroy many species of voles. In Australia they are known as effective agents in the control of locusts.[2]

Sandhill Crane (*Grus mexicana*); feeds extensively on vegetation—roots, bulbs, berries, grains—as well as insects, frogs, reptiles and mice; fond of corn.[3] Florida stomachs contained frogs and toads.[4] One bird 2 months old, in captivity, often

[1] Aughey, 1st Rept. *U. S. Entom. Com.*, 56-57, 1878.
[2] Riley and Howard, *Insect Life*, IV, 409, 1891-2. Lantz, *U. S. Biol. Surv., Bull.* 31, 53, 1907. Forbush, *Game Birds, Wild-fowl and Shore Birds*, 65, 1912.
[3] Barrows, *Michigan Bird Life*, 150, 1912.
[4] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1889.

ate a quart of cicadas in a day.[5] Little Brown Crane (*Grus canadensis*); 1 California stomach contained plants and waste barley.[6] Another was filled with barley, "probably from sowed fields."[7]

Family Rallidæ. *Rails, Gallinules and Coots*

King Rail (*Rallus elegans*); some found stuffed with oats; in late summer and autumn feeds largely on grasshoppers.[8] California Clapper Rail (*R. obsoletus*); 1 California stomach contained a good-sized frog, and several contained crabs; feeds entirely on animal matter—worms, crustaceans, etc.[9] Caribbean Clapper Rail (*R. longirostris caribæus*); 11 stomachs, Porto Rico; 2 empty; contents of the others entirely animal matter; crustaceans, 94.45%, chiefly fiddler crabs; 1 contained fish.[10] Virginia Rail (*R. virginianus*); summer food chiefly worms, snails and crustaceans, varied by fruits, seeds and grains when available.[11] One California stomach contained only beetles.[12] In 9 days, 1 in captivity ate 5 caterpillars, 29 waterbugs, 200 mealworms, 27 grasshoppers, 18 hornets, 111 caddis larvæ, 7 water scorpions, 23 house flies, 717 amphipods, 3 crayfish, 14 snails, 46 earthworms, 18 sunfish, 3 sticklebacks, 4 bullheads, 2 snakes, 4 frogs.[13]

Sora (*Porzana carolina*) feeds on insects, snails and seeds, especially wild rice; 1 stomach, 200 grains of rice.[14] Yellow Rail (*Coturnicops noveboracensis*); 1 California stomach, November 17, when insects were not so abundant, contained clover seeds and grass.[15] One South Carolina stomach contained fresh-water snails.[16] California Black Rail (*Creciscus*

[5] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 433.
[6] Fisher, *North American Fauna*, No. 7, 20-21, 1893.
[7] Grinnell, Bryant and Storer, *Game Birds of California*, 278, 1918.
[8] Barrows, *Michigan Bird Life*, 153, 1912.
[9] Grinnell, Bryant and Storer, *Game Birds of California*, 288, 1918; citing for first item, Bryant, *Zoe*, IV, 55, 1893.
[10] Wetmore, *U. S. Dept. Agric., Bull.* 326, 36-37, 1916.
[11] Barrows, *Michigan Bird Life*, 155, 1912.
[12] Grinnell, Bryant and Storer, *Game Birds of California*, 295, 1918.
[13] Cahn, *Auk*, XXXII, 92, 1915.
[14] Barrows, *ibid.*, 156.
[15] Bryant, *Condor*, XV, 92, 1913.
[16] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 214, 1912.

coturniculus); 1 captive bird took 8 earthworms for a single meal.[17] Birds from the Farollon Islands contained isopod crustaceans.[18]

Florida Gallinule (*Gallinula chloropus cachinnans*); food largely insects, chiefly aquatic, according to Barrows;[19] but in Porto Rico 4 stomachs contained vegetable matter, 96.75% (grass and rootlets, 90.75%; seeds of grass, purslane, pigweed, heliotrope, etc., 6%); animal matter, 3.25% (insects and mollusks); another contained crustacean? eggs, 95%; grass, 5%.[20]

Coot (*Fulica americana*); omnivorous, feeds most extensively on grass seeds and aquatic plants, but takes insects, snails, tadpoles and has been known to feed even upon dead ducks; pondweed a favorite in most localities; grain when available; not to any marked extent a fish eater.[21] One stomach, Porto Rico, contained a water beetle and crustaceans and their eggs; another contained a large quantity of grass or sedge and some roots.[22] One shot at carp ponds contained 38 young carp, as should have been expected where they were so easily procurable.[23]

[17] Grinnell, Bryant and Storer, *ibid.*, 308.
[18] Huey, *Condor*, XVIII, 60, 1916.
[19] Barrows, *Michigan Bird Life*, 162, 1912.
[20] Wetmore, *U. S. Dept. Agric., Bull.* 326, 35, 1916
[21] Grinnell, Bryant and Storer, *Game Birds of California*, 319, 1918. Barrows, *Michigan Bird Life*, 164, 1912. Judd, *U. S. Biol. Surv., Bull.* 17, 81, 1902. Anderson and Jenkins, *Condor*, V, 154, 1903.
[22] Wetmore, *U. S. Dept. Agric., Bull.* 326, 34, 1916.
[23] Smiley, *Biennial Rept. Fish Com. of Colorado for* 1884.

ORDER LIMICOLÆ. SHORE BIRDS

During the past half century there has been a marked decrease in the numbers of Shore Birds, and some species are nearing extinction. For example, the Eskimo Curlew, formerly found in closely packed flocks, is now scarce, and the Woodcock, once common, is now rare.[1] The Shore Birds are on the whole very useful, some of them feeding extensively on injurious insects and scarcely any of them having destructive habits, unless under very exceptional conditions. A few species are known to take some small fishes, mostly worthless. In the West Indies the following species have been found to eat fishes from ½ to 1½ inches long: Golden Plover, Turnstone, Willett, Greater and Lesser Yellow-legs, and Solitary and Spotted Sandpipers.[2]

The table on page 172, showing the kinds of destructive insects, etc., known to be eaten by certain species of Shore Birds is a condensation and tabulation of a paper by McAtee.[3]

From Aughey's great report on the food of Nebraska birds the following items are extracted and presented in tabular form:[4]

[1] See Cooke, "Our Shore Birds and their Future," Yearbook *U. S. Dept. Agric. for* 1914, 275-294. McAtee, "Our Vanishing Shore Birds," *U. S. Biol. Surv., Circular* 79, 1911. Fisher, "Two Vanishing Game Birds: The Wood Cock and the Wood Duck," *Yearbook U. S. Dept. Agric. for* 1901, 447-458.

[2] Clarke, "Shore Birds Eating Small Fish," *Auk*, XXII, 208-209, 1905.

[3] McAtee, "Our Vanishing Shore Birds," *U. S. Biol. Surv., Circular* 79, 1911.

[4] Aughey, 1st Rept. *U. S. Entom. Com.*, 49-55, 1878.

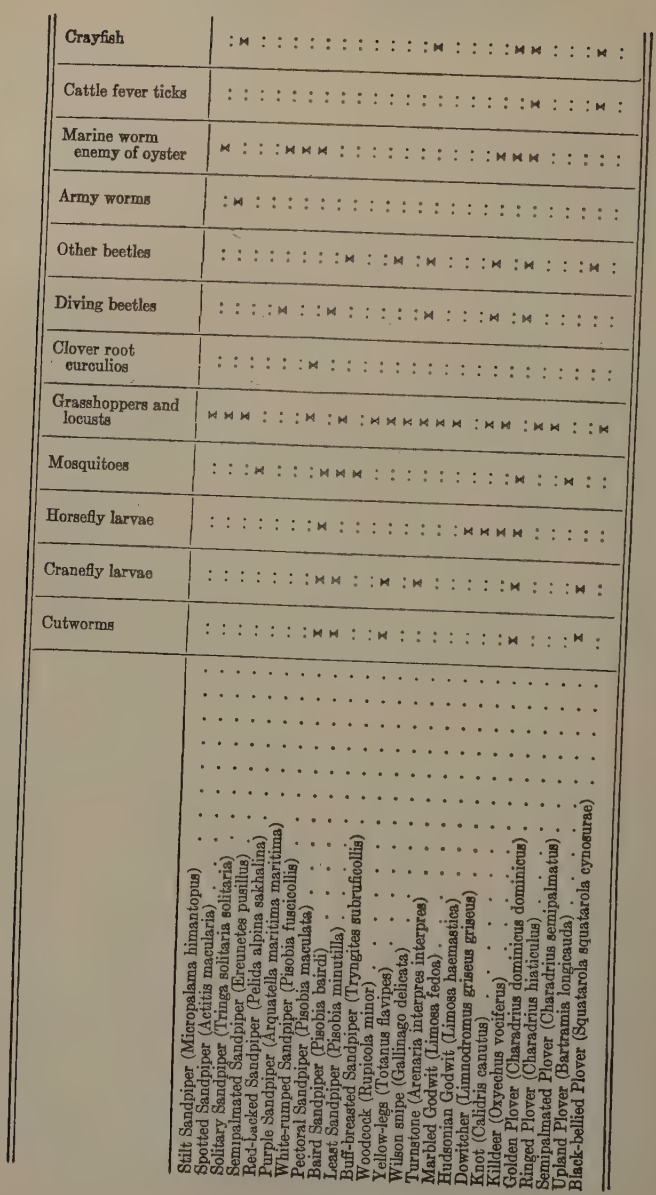
	Number of stomachs	Locusts average number	Other insects average number	Seeds average number
[5] Wilson Phalarope, Steganopus tricolor	8	..	57	..
Avocet, Recurvirostra americana	3	many	many	..
Woodcock, Rupicola minor	1	32	x	..
Wilson Snipe, Gallinago delicata	11	37	33	..
Dowitcher, Limnodromus griseus griseus	6	5	54	..
Knot, Calidris canutus	1	11	many	..
Baird Sandpiper, Pisobia bairdi	5	9	34	..
Least Sandpiper, Pisobia minutilla	8	18	26	..
Semipalmated Sandpiper, Ereunetes pusillus	2	..	full	..
Marbled Godwit, Limosa fedoa	6	7	36	..
[5] Greater Yellow-legs, Totanus melanoleucus	6	..	50	..
Yellow-legs, Totanus flavipes	5	12	31	..
Solitary Sandpiper, Tringa solitaria solitaria	2	4	39	..
Upland Plover, Bartramia longicauda	22	37	16	..
Spotted Sandpiper, Actitis macularia	6	15	24	..
Buff-breasted Sandpiper, Tryngites subruficollis	1	42	x	..
Long-billed Curlew, Numenius americanus	10	48	15	12
Eskimo Curlew, Numenius borealis	1	31	..	..
Black-bellied Plover, Squatarola squatarola cynosuræ	2	full	..	..
[5] Golden Plover, Charadrius dominicus dominicus	4	..	full	..
Semipalmated Plover, Charadrius semipalmata	11	38	19	..
Piping Plover, Charadrius melodus	4	26	31	..
Killdeer, Oxyechus vociferus	9	29	20	x
Mountain Plover, Podasocys montanus	16	47	13	..

The following table is a summary from Wetmore's bulletin on the food of Phalaropes, Avocets and Stilts: [6]

Number of stomachs	36	155	106	67	80
	Red Phalarope Phalaropus fulicarius	Northern Phalarope Lobipes lobatus	Wilson Phalarope Steganopus tricolor	Avocet Recurvirostra americana	Black-necked Stilt Himantopus mexicanus
	Food percentages				
Vegetable matter, chiefly seeds of marsh and aquatic plants	Trace	2.8	6.7	34.9	1.1
Animal matter	100.0	97.2	93.3	65.1	98.9
Crustacea	33.5	9.3	3.6	8.6	.5
Odonata, Tricoptera, Ephemerida	..	.2	..	.1	7.5
Hemiptera	..	31.8	24.4	5.9	35.0
Coleoptera	27.3	16.5	20.1	11.4	32.4
Diptera	22.7	32.8	43.1	23.8	9.7
Mollusca	..	2.7	0.3	0.8	7.9
Fishes	6.8	..	..	..	3.2
Miscellaneous animal matter	9.7	3.9	1.8	14.5	2.7

[5] Not taken in locust years.

[6] Wetmore, "Food of American Phalaropes, Avocets and Stilts," *U. S. Dept. Agric., Bull.* 1359, 1925.


Crayfish
Cattle fever ticks
Marine worm enemy of oyster
Army worms
Other beetles
Diving beetles
Clover root curculios
Grasshoppers and locusts
Mosquitoes
Horsefly larvae
Cranefly larvae
Cutworms
Stilt Sandpiper (Micropalama himantopus)
Spotted Sandpiper (Actitis macularia)
Solitary Sandpiper (Tringa solitaria solitaria)
Semipalmated Sandpiper (Ereunetes pusillus)
Red-backed Sandpiper (Pelidna alpina sakhalina)
Purple Sandpiper (Arquatella maritima maritima)
White-rumped Sandpiper (Pisobia fuscicollis)
Pectoral Sandpiper (Pisobia maculata)
Baird Sandpiper (Pisobia bairdi)
Least Sandpiper (Pisobia minutilla)
Buff-breasted Sandpiper (Tryngites subruficollis)
Woodcock (Rupicola minor)
Yellow-legs (Totanus flavipes)
Wilson snipe (Gallinago delicata)
Turnstone (Arenaria interpres interpres)
Marbled Godwit (Limosa fedoa)
Hudsonian Godwit (Limosa haemastica)
Dowitcher (Limnodromus griseus griseus)
Knot (Calidris canutus)
Killdeer (Oxyechus vociferus)
Golden Plover (Charadrius dominicus dominicus)
Ringed Plover (Charadrius hiaticulus)
Semipalmated Plover (Charadrius semipalmatus)
Upland Plover (Bartramia longicauda)
Black-bellied Plover (Squatarola squatarola cynosurae)

Family PHALAROPODIDÆ. *Phalaropes*

According to Barrows the food of all Phalaropes seems to consist entirely of animal forms, mainly of minute mollusks, crustaceans and aquatic insects.[7] Red Phalarope (*Phalaropus fulicarius*); food mostly small crustaceans.[8] Northern Phalarope (*Lobipes lobatus*); food chiefly aquatic worms and insects and crustaceans. In 28 stomachs, mosquitoes, 3%; contained also craneflies, grasshoppers and clover root curculios; eats diving beetles, which prey on insect food of fishes.[9] Wilson Phalarope (*Steganopus tricolor*); feeds on a great variety of insects, aquatic and terrestrial, and on snails, etc.[10] Several Lake Erie specimens were filled with small worms and delicate shells of mollusks.[11]

Family RECURVIROSTRIDÆ. *Avocets and Stilts*

Avocet (*Recurvirostra americana*); eats grasshoppers, cutworms, harmful beetles and other insects.[12] Coues and Yarrow found crops filled with insect larvæ.[13] One Florida bird contained 16 fish less than 1 inch long.[14] A downy young bird contained 8 water beetles, 1 cricket, 1 dragonfly, 1 bug and 1 centipede.[15]

Black-necked Stilt (*Himantopus mexicanus*); known to eat grasshoppers, harmful beetles and crayfish.[16] Two stomachs, Porto Rico; contained animal matter only; water-boatmen, about ½; small fish scales, 40%.[17]

[7] Barrows, *Michigan Bird Life*, 168, 1912.
[8] Grinnell, Bryant and Storer, *Game Birds of California*, 323, 326, 1918; citing McGregor, *Osprey*, II, 87-88, 1898.
[9] McAtee, *U. S. Biol. Surv., Circular* 79, 2, 4, 6, 1911.
[10] Grinnell, Bryant and Storer, *ibid.*, 337. See also McAtee, *ibid.*, 2, 4, 6.
[11] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 230, 1912.
[12] McAtee, *U. S. Biol. Surv., Circular* 79, 4, 6, 1911.
[13] Coues and Yarrow, "Rept. Geol. and Geog. Explor. and Surv. W. of 100th Meridian (Wheeler Survey)," V, *Zoology*, 449, 1875.
[14] Grinnell, Bryant and Storer, *Game Birds of California*, 343, 1918.
[15] Bryant, *Condor*, XVI, 226, 1914.
[16] McAtee, *Circular* 79, 4, 6, 8.
[17] Wetmore, *U. S. Dept. Agric., Bull.* 326, 45, 1916.

Family SCOLOPACIDÆ. *Snipes, Sandpipers, Woodcocks and Curlews*

Woodcock (*Rupicola minor*); now becoming rare; 100 stomachs, containing nothing but earthworms, except a leech in 1 and another filled with fern leaves.[18] One contained only seeds, others contained beetles, larvæ and a spider.[19] Feeds on boring insects and many others. Wilson Snipe (*Gallinago delicata*); 1 stomach, Porto Rico; vegetable matter, 60%, mainly grass, wood and seeds; beetles and 1 ant, 30%; mole crickets, 10%.[20] Dowitcher (*Limnodromus griseus griseus*); 1 stomach contained maggots, probably of the beach fly that breeds upon decaying seaweeds.[21]

Knot (*Calidris canutus*); food mollusks, marine worms, cutworms, grasshoppers, beetles, caterpillars and rarely plants.[22] At Cape Hatteras, feeds largely on small clams (*Donax*), but takes also other mollusks, cutworms, etc.[23] Purple Sandpiper (*Arquatella maritima maritima*); food chiefly mollusks, especially marine mussels, but takes also barnacles, insects and seeds.[24] Pribilof Sandpiper (*A. m. ptilocnemis*); 2 downy young birds had eaten a seed, a fly, a quantity of carabid beetles and parasitic wasps.[25]

Pectoral Sandpiper (*Pisobia maculata*); food various insects, worms, mollusks and plants.[26] Least Sandpiper (*P. minutilla*); 1 stomach, Porto Rico; fly larvæ, 75%; beetles, 25%.[27] Semipalmated Sandpiper (*Ereunetes pusillus*); 2 Nebraska stomachs crowded with worms and aquatic insects.[28] Six stomachs, Porto Rico; animal matter, 99.16%

[18] Webster, *Auk*, IV, 73-74, 1887.
[19] Barrows, *Michigan Bird Life*, 175, 1912.
[20] Wetmore, *U. S. Dept. Agric., Bull.* 326, 44-45, 1916.
[21] Norton, *Auk*, XXVI, 439-440, 1909.
[22] Grinnell, Bryant and Storer, *Game Birds of California*, 268, 1918.
[23] Mackay, *Auk*, X, 27, 1893.
[24] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 269, 1912. Norton, *Auk*, XXVI, 439-440, 1909.
[25] Judd, *Yearbook U. S. Dept. Agric. for* 1900, 432.
[26] Grinnell, Bryant and Storer, *Game Birds of California*, 273, 1918.
[27] Wetmore, *U. S. Dept. Agric., Bull.* 326, 44, 1916.
[28] Aughey, 1st Rept. *U. S. Entom. Com.*, 52, 1878.

(water scavenger beetles, 27%; ground beetles, 5; other beetles, 3.34; Notonecta, 16.66; fly pupæ, 21.6; snails, 13; miscellaneous, 12.5).[29] Sanderling (*Calidris alba*); feeds on mollusks, crustaceans, worms, insects, and, in the far North, buds of saxifrage.[30] Audubon found marine worms, mollusks and crustaceans in stomachs.[31] Florida stomachs contained mollusks, chiefly *Odostomia*.[32] Marbled Godwit (*Limosa fedoa*); food crustaceans, insects, worms, leeches and snails.[33]

Greater Yellow-legs (*Totanus melanoleucus*); food insects, snails, worms and small fish; 2 Los Banos, California, stomachs; beetles in 1, crickets in the other; 1 from Santa Barbara, crammed to the bill with minnows about an inch long.[34] One stomach, Porto Rico; full of crustaceans and aquatic insect larvæ.[35] Lesser Yellow-legs (*T. flavipes*); 4 stomachs, Porto Rico; water-boatmen, 57.5%; crustaceans, 42.5%.[36]

Solitary Sandpiper (*Tringa solitaria solitaria*); 2 stomachs, Porto Rico; over ½ of contents dragonfly nymphs, balance mostly water-scavenger beetles.[37] Audubon found stomachs filled with aquatic insects, caterpillars and spiders; 1 examined by Warren contained mollusks and 10 contained insects.[38] Willett (*Catoptrophorus semipalmatus inornatus*); 1 California stomach contained clams 1½ inches long.[39] Florida stomachs contained small mollusks, *Odostomia* and *Gemma*.[40]

Upland Plover (*Bartramia longicauda*); one of the most useful of Shore Birds; because of its habitat, it feeds largely upon insects, especially destructive species such as grasshoppers, locusts, crickets, white grubs, cutworms and wire-

[29] Wetmore, *ibid.*, 43.
[30] Barrows, *Michigan Bird Life*, 189, 1912.
[31] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 293, 1912.
[32] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1889.
[33] Grinnell, Byrant and Storer, *Game Birds of California*, 401, 1918.
[34] Grinnell, Bryant and Storer, *ibid.*, 407.
[35] Wetmore, *U. S. Dept. Agric., Bull.* 326, 43, 1916.
[36] Wetmore, *ibid.*, 42-43.
[37] Wetmore, *ibid.*, 42.
[38] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 308, 1912.
[39] Grinnell, Bryant and Storer, *Game Birds of California*, 422, 1918.
[40] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1889.

worms; while in Labrador, it feeds extensively on crowberries.[41] In Texas 48 stomachs were filled with weevils of various species.[42] One California stomach contained only grasshoppers.[43] In 163 stomachs nearly ½ the food was grasshoppers, crickets and weevils, besides many other injurious insects; 97% of its food is animal matter, chiefly injurious and neutral forms.[44]

Spotted Sandpiper (*Actitis macularia*); in United States, food almost entirely animal matter, chiefly insects.[45] Nine stomachs, Porto Rico; animal matter, 97.7% (crustaceans, 80.12; mole crickets, 10.78; beetles, 3.89; aquatic bugs, 4.11; ants and earwigs, 0.88).[46]

Long-billed Curlew (*Numenius americanus*); food varied, largely insects, with berries, seeds, crustaceans, mollusks, toads, worms, spiders, etc.[47] Hudsonian Curlew (*N. hudsonicus*); along seashore, food crustaceans and other marine life; inland, includes insects, spiders and worms; in the North, late summer and autumn, feeds on various wild berries.[48]

Family Charadriidæ. *Plovers*

Black-bellied Plover (*Squatarola squatarola cynosuræ*); food small mollusks, earthworms and insects (mostly injurious); in North, eats berries in late summer; 1 California stomach, 14 small snails, 1 bivalve mollusk and parts of crabs.[49] In Massachusetts, feeds on cutworms, grasshoppers and other insects and small shell-fish.[50]

[41] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 347, 1912. Grinnell, Bryant and Storer, *Game Birds of California*, 462, 463, 1918.
[42] Howell, *U. S. Biol. Surv., Bull.* 29, 20, 1907.
[43] Bryant, *Univ. Calif. Pub. Zool.*, XI, No. 1, 9, 1912.
[44] McAtee and Beal, *Farmers' Bull.* 497, 15-16, 1912. *Farmers' Bull.* 513, 30, 1913.
[45] Barrows, *Michigan Bird Life*, 203, 1912. Grinnell, Bryant and Storer, *Game Birds of California*, 437, 1918.
[46] Wetmore, *U. S. Dept. Agric., Bull.* 326, 41, 1916.
[47] Barrows, *Michigan Bird Life*, 204, 1912. Wickersham, *Auk*, XIX, 355, 1902.
[48] Grinnell, Bryant and Storer, *Game Birds of California*, 451, 1918. Forbush, *Game Birds, Wild-fowl and Shore Birds*, 333, 1912.
[49] Grinnell, Bryant and Storer, *Game Birds of California*, 458, 1918.
[50] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 339, 1912. Mackay, *Auk*, IX, 146, 1892.

Killdeer (*Oxyechus vociferus*); a very useful species; takes many species of harmful insects; 1 Texas stomach contained 300 mosquito larvæ.[51] Food 97.72% animal matter, mostly worms and insects.[52] Some stomachs completely filled with weevils.[53] In western alfalfa fields; April stomachs, alfalfa weevils, 3.5%; caterpillars, 37%; ground beetles, 19.3%; May stomachs, alfalfa weevils, 36%; June stomachs, weevils nearly ½; 1 contained 316 weevils, another 383.[54] A few southern stomachs contained cotton-boll weevils.[55] One California stomach obtained during grasshopper outbreak; grasshoppers, 100%.[56] Antillean Killdeer (*O. v. rubidus*); 20 stomachs, Porto Rico; vegetable matter, mostly weed seeds, 1.6%; animal matter, 98.34% (mole crickets, 14.42; other Orthoptera, 2.04; weevils, 3.09; other Coleoptera, 29.17; fly larvæ, 19.53; ants, 5.59, including 1 very destructive species; dragonflies, 3.92; miscellaneous insects, 1.56; snails, 19.02; some fish remains in 1).[57]

Semipalmated Plover (*Charadrius semipalmatus*); on coast, feeds largely on crustaceans, mollusks, eggs of marine animals and insects; interior, feeds on locusts and other Orthoptera and many other insects. Snowy Plover (*C. nivosus*); Owens Lake, California, found feeding exclusively on small flies (*Ephydra*).[58]

Family Aphrizidæ. *Surf-birds and Turnstones*

Surf-bird (*Aphriza virgata*); at Santa Barbara found feeding on barnacles; probably takes also small mollusks, etc.[59]

Ruddy Turnstone (*Arenaria interpres morinella*); food in-

[51] *U. S. Dept. Agric., Bull.* 513, 30, 1913.
[52] McAtee and Beal, *Farmers' Bull.* 497, 18, 1912.
[53] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 351, 1912; citing Nash, *Birds of Ontario*, 1909.
[54] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 6-7, 1914.
[55] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905. Howell, *U. S. Biol. Surv., Bull.* 25, 14, 1906; *Bull.* 29, 20, 1907.
[56] Bryant, *Univ. Calif. Pub. Zool.*, XI, No. 1, 9, 1912.
[57] Wetmore, *U. S. Dept. Agric., Bull.* 326, 39, 1916.
[58] Fisher, *North American Fauna*, No. 7, 25, 1893.
[59] Grinnell, Bryant and Storer, *Game Birds of California*, 488, 1918.

sects, crustaceans and mollusks.[60] In Maine, eats mussels (*Mytilus*) and barnacles.[61] Five stomachs, Porto Rico; only animal matter, chiefly crustaceans and a few fish scales.[62] Black Turnstone (*A. melanocephala*); 1 Alaska stomach; contained heath berries; food probably largely marine invertebrates.[63]

Family Hæmatopodidæ. *Oyster-catchers*

Black Oyster-catcher (*Hæmatopus bachmani*); popular name a misnomer; rarely feeds on oysters; mussels, chitons, limpets and young abalones its chief food.[64] In Alaska feeds chiefly on limpets.[65] Three California crops were filled with mussels.[66]

[60] Grinnell, Bryant and Storer, *ibid.*, 493.
[61] Norton, *Auk*, XXVI, 439, 440, 1909.
[62] Wetmore, *U. S. Dept. Agric., Bull.* 326, 40-41, 1916.
[63] Grinnell, Bryant and Storer, *Game Birds of California*, 497, 1918.
[64] Grinnell, Bryant and Storer, *ibid.*, 501. Willett, *Condor*, XI, 187, 1909.
[65] Willett, *Lorquina*, II, 33, 1917. See also for California, Williams, *Condor*, XXIX, 80, 1927.
[66] Swarth, *Bull. Cooper Orn. Club* (*Condor*), I, 85, 1899.

ORDER GALLINÆ. GROUSE, QUAILS, TURKEYS, ETC.

Some species of these birds are very useful, destroying large quantities of injurious insects and weed seeds. Aughey's report on Nebraska birds in their relation to insects furnishes the following items: [1]

	Number of stomachs	Average number of locusts	Average number of other insects	Vegetation (seeds, etc.)
Prairie Chicken, Tympanuchus americanus	21	41	10	x
Prairie Sharp-tailed Grouse, Pediœcetes phasianellus phasianellus	10	17	10	x
Sage Hen, Centrocercus urophasianus	4	47	3	x
Bob-white, Colinus virginianus virginianus	21	25	14	x
Wild Turkey, Meleagris silvestris	6	43	18	x

The table on the following page is constructed with data gleaned from Judd's excellent reports on Grouse, Wild Turkeys and Quails.[2]

The foliage item of the Spruce Partridge and Dusky Grouse is mostly conifer leaves, the fruit item of the Spruce chiefly bearberries and of the Dusky largely manzanita. The leaf

[1] Aughey, 1st Rept. *U. S. Entom. Com.*, 46-48, 1878.

[2] Judd, "The Grouse and Wild Turkeys of the United States and their Economic Value," *U. S. Biol. Surv., Bull.* 24, 1905; "The Bob-white and Other Quails of the United States in their Economic Relations," *U. S. Biol. Surv., Bull.* 21, 1905; "The Economic Value of the Bob-white," *Yearbook U. S. Dept. Agric. for* 1903, 193-204. See also Judd, *U. S. Biol. Surv., Bull.* 17, 1902. Beal, *U. S. Biol. Surv., Bull.* 34, 9-14, 1910.

Kinds of Food	Mearns Quail (Cyrtonyx montezumae mearnsi)	Gambel Quail (Lophortyx gambeli)	California Quail (Lophortyx californicus californicus)	Scaled Quail (Callipepla squamata pallida)	Mountain Quail (Oreortyx picta picta)	Masked Bob-white (Colinus ridgwayi)	Bob-white (Colinus virginianus virginianus)	[a] Sharp-tailed Grouse (Pediocectes phasianellus, subspecies)	Prairie Chicken (Tympanuchus americanus)	Ruffed Grouse (Bonasa umbellus umbellus)	Canada Spruce Partridge (Canachites canadensis canace)	Dusky Grouse (Dendragapus obscurus obscurus)	Willow Ptarmigan (Lagopus lagopus lagopus)	Wild Turkey (Meleagris gallapavo silvestris)
Number of stomachs	9	28	601	47	23	3	918	43	71	208	8	45	5	16
	Percentages													
Vegetable matter	....	99.52	97.85	70.04	97.	....	83.59	89.81	85.89	89.08	100.00	93.27	100.00	84.43
Weed and other seeds	x	31.89	59.77	52.85	46.61	x	52.83	7.39	14.87	11.79	18.33	4.99	....	24.72
Grain	....	3.89	6.18	0.57	18.10	....	17.38	20.50	31.06	....	....	....	....	....
Fruits, mostly wild	....	....	7.06	12.65	8.11	x	9.57	27.68	11.79	28.32	19.73	20.09	10.00	32.98
Leaves and buds	....	63.74	22.73	4.33	24.08	x	....	31.87	25.09	48.11	61.94	68.19	90.00	24.80
Miscellaneous	x	....	....	....	....	....	....	3.06	3.08	0.86	....	....	....	....
Animal matter	....	2.15	....	3.00	....	....	16.41	10.19	14.11	10.92	....	6.73	....	15.57
Grasshoppers	....	....	15.86	....	x	....	3.71	4.62	12.78	0.78	....	5.73	....	....
Beetles	....	....	10.43	....	x	....	6.92	2.86	0.48	4.57	....	....	....	....
Hymenoptera	....	....	3.27	....	x	....	0.95	....	0.29	1.15	....	....	....	....
Bugs	....	....	....	....	....	....	2.77	0.50	0.39	....	....	....	....	....
Spiders	....	....	0.30	x	....	....	1.36	....	0.05	....	....	x	....	....
Miscellaneous	x	....	2.15	....	x	....	0.70	2.21	....	3.86	....	1.00	....	15.57

[a] The subspecies of Sharp-tailed Grouse were not differentiated, but probably included the Prairie, Columbian and Northern.

and bud item of the Ptarmigan is ½ willow buds, 1 containing 300 of them. The animal matter of the Turkey is 15.15% insects; in Arizona it feeds on pinyon nuts and in New Mexico on grass, seeds and grasshoppers.

Family Odontophoridæ. *Bob-whites, Quails, etc.*

Bob-white (*Colinus virginianus virginianus*); a very useful bird. About ½ its food is weed seeds, with some grain, chiefly from stubble fields; insects 15%, including some of the most serious pests. One stomach contained 5,000 pigeon-grass seeds; another (Kansas), 1,000 millet seeds; another (Virginia), 10,000 pigweed seeds; many gorged with ragweed seeds; estimated that in Virginia and North Carolina it eats 1,341 tons of weed seeds between September 1 and April 30, while during the summer months, when ⅓ of its food consists of insects, it still consumes 340 tons of weed seeds.[4] Two stomachs from a canker-infested orchard contained corn and other seeds, chiefly Compositæ, 96%; the only insects being 3 beetles.[5] In Texas, out of 200 stomachs, only 1 contained a cotton-boll weevil.[6] In experiments with captive Bob-whites, insects were taken as follows, each number representing a meal for 1 bird: Chinch-bugs, 100; squashbugs, 12; plant lice, 2,326; grasshoppers, 39; cutworms, 12; army worms, 12; mosquitoes, 568; potato beetles, 101; white grubs, 8; daily rations, each number representing 1 bird's food for 1 day: Chrysanthemum black flies, 5,000; flies, 1,350; rose slugs, 1,286; miscellaneous insects, 700 (of which 300 were grasshoppers); insects, 1,532 (of which 1,000 were grasshoppers); seeds at a single meal varied, but up to 400 pigweed, 5,000 lamb's-quarter; and for 1 day, up to 600 burdock and 30,000

[4] Judd, *U. S. Biol. Surv., Bull.* 21, 14-15, 1905; *Yearbook U. S. Dept. Agric. for* 1898, 231; *Yearbook* for 1903, 193-204. Sullivan, *Economic Study of Bird Life*, 32, 1912.
[5] Forbes, *Bull. Illinois State Lab. Nat. Hist.*, I, No. 6, 17, 1883.
[6] Howell, *U. S. Biol. Surv., Bull.* 25, 13, 1906; *Bull.* 29, 20, 1907. Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905.

rabbit-foot clover.[7] They exhibit a particular fondness for ripe mulberries, when available.[8]

Mountain Quail (*Oreortyx picta picta*); food mostly seeds and insects; 1 contained 575 seeds of turkey mullein; in autumn, service berries the staple diet; also eats acorns.[9] Scaled Quail (*Callipella squamata pallida*) several hundred scale insects in one stomach.[10] In Oklahoma it feeds upon grasshoppers, flies, ants, beetles and seeds of sunflower, Russian thistle, lamb's-quarter, maize, kaffir and millet.[11]

California Quail (*Lophortyx californica californica*); 2,000 dog fennel seeds in one.[12] Fruit in 601 stomachs, 7.06% of the food for the year; 0.01% identified as grapes; in December 34.40% fruit, but doubtless waste fruit, as the harvest is over by that time;[13] does some damage locally at times, without doubt; numbers too easily controlled for serious danger. Valley Quail (*L. c. vallicola*); 5 stomachs, taken during an alfalfa weevil outbreak in Utah; weevils, 32.4%; vegetable matter, 66%, mostly weed seeds; 1 contained 400 alfalfa seeds; no danger of damage to alfalfa fields, as numbers easily controlled by short open season.[14] Gambel Quail (*L. gambeli*); stomachs from along Colorado River contained masses of mistletoe berries; feeds also on fruits and seeds of cactus.[15]

Family Tetraonidæ. *Grouse, Spruce Partridges, Ptarmigan, Etc.*

Dusky Grouse (*Dendragapus obscurus obscurus*); food summarized in a table on a preceding page. September stom-

[7] Forbush, *Game-Birds, Wild-fowl and Shore Birds*, 373-374, 1912.
[8] Stoddard, "Progress on Co-operative Quail Investigations," Div. of Food Habits Research, *U. S. Biol. Surv.*, 7, 1925.
[9] Grinnell, Bryant and Storer, *Game Birds of California*, 511-512, 1918.
[10] Judd, *U. S. Biol. Surv., Bull.* 21, 61-63, 1905.
[11] Tate, *Bull. Univ. Okla.*, n. ser., No. 322, 33, 1925.
[12] Judd, *ibid.*, 49-56.
[13] Beal, *Yearbook U. S. Dept. Agric. for* 1904, 250. See also McAtee and Beal, *Farmers' Bull.* 497, 9, 1912.
[14] Kalmbach, "Birds in Relation to the Alfalfa Weevil," *U. S. Dept. Agric., Bull.* 107, 8, 1914.
[15] Grinnell, Bryant and Storer, *Game Birds of California*, 543, 1918.

achs from the foothills of eastern Colorado were crammed with kinnikinick berries.[16] Sooty Grouse (*D. o. fuliginosus*); food during entire winter almost exclusively buds and tender tops of pine and fir branches, as well as full-grown needles.[17] Sierra Grouse (*D. o. sierræ*); stomach contents indicate that favorite food is thimble berries; service berries next; takes also gooseberries, elderberries, manzanita, twinberries, bilberries, lupine, false sunflower, caraway, miterwort and acorns; young take insects and native clover; in late autumn they move up the mountains and feed on foliage of fir, hemlock, etc.; 1 from an altitude of 11,000 feet contained pollen cones of pine; another, 1,520 pine needletips; another rose hips and seeds; another, berries and fir needles.[18]

Canada Spruce Partridge (*Canachites canadensis canace*); in summer feeds much on foliage of spruce and fir, berries and insects; in winter, largely on buds of evergreen trees.[19] Franklin Grouse (*Canachites franklini*); food largely wild fruits, leaves and buds. Idaho stomachs, September, filled with lodgepole pine needles.[20]

Ruffed Grouse (*Bonasa umbellus umbellus*); vegetable food mostly fruits, mast and browse; fond of hazelnuts, beechnuts, chestnuts and acorns; 60 kinds of fruits identified; insects, 10%, including potato beetles, grasshoppers, army worms, cutworms, sawfly larvæ and other destructive species.[21] One stomach, immature; insects, 3%; vegetable matter, 97% (browse and leaves, 20%, mostly touch-me-not; seeds as follows: 105 touch-me-not, 22%; 1,750 blackberry, 31%; 514 violet, 14%; 100 ground cherry, 2%; 462 sedge, 4%; rushes, 1%; grass, 2%; sorrel, 1%).[22] Oregon Ruffed Grouse (*B. u. sabini*); stomachs from Vancouver Island; some contained berries, but most of them were filled with fern leaves and

[16] Lincoln, *Auk*, XXXVII, 65, 1920.
[17] Bendire, *Auk*, VI, 33, 1889.
[18] Grinnell, Bryant and Storer, *Game Birds of California*, 550-551, 1918; citing Belding, *Zoe*, III, 232-233, 1892.
[19] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 377, 1912.
[20] Judd, *U. S. Biol. Surv., Bull.* 24, 40, 1905.
[21] *Farmers' Bull.* 513, 29, 1913.
[22] Weber, *Auk*, XXII, 459-460, 1906.

clover; 1 contained only small snails; 1 from California contained madrona seeds and berries, 5%; thimbleberries, 65%; dogwood, 20%; undetermined vegetation, 10%.[23]

Willow Ptarmigan (*Lagopus lagopus lagopus*); principal food buds and leaves of birch and willow, with a few berries and insects.[24] White-tailed Ptarmigan (*L. leucurus leucurus*); in winter, feeds largely on willow buds; 2 Colorado stomachs, January, contained undetermined bud twigs; 2 downy chicks contained beetles and flowers of heather and blueberry.[25] Rock Ptarmigan (*L. rupestris rupestris*); feeds on berries, buds, leaves, etc.[26]

Prairie Chicken (*Tympanuchus americanus americanus*); food largely insects when obtainable; not infrequently feeds solely on grasshoppers for weeks at a time; grains and seeds eaten freely, and, in cold weather, buds, berries and leaves.[27] Heath Hen (*T. cupido*); now extinct over most of its former range; food various insects, berries, seeds, nuts, buds, etc.[28]

Sage Hen (*Centrocercus urophasianus*); unlike most upland game birds, it has no true gizzard for grinding hard food; principal diet is sage-brush, but takes also leaves, buds, shoots and berries of other shrubs; in spring and summer, insects added; a large number dissected contained only grasshoppers and sage-brush leaves; young birds more insectivorous.[29]

Family Meleagridæ. *Turkeys*

Wild Turkey (*Meleagris gallapavo silvestris*); extinct over most of its former range; food percentages given in a table on a preceding page.

[23] Grinnell, Bryant and Storer, *Game Birds of California*, 557, 1918.
[24] Barrows, *Michigan Bird Life*, 229, 1912.
[25] Judd, *U. S. Biol. Surv., Bull.* 24, 47-48, 1905.
[26] Judd, *ibid.*, 46-47.
[27] Barrows, *Michigan Bird Life*, 233, 1912. McAtee and Beal, *Farmers' Bull.* 497, 7, 1912.
[28] Forbush, *Game Birds, Wild-fowl and Shore Birds*, 393, 1912. Judd, *U. S. Biol. Surv., Bull.* 24, 18-19, 1905.
[29] Judd, *ibid.*, 23-25. Grinnell, Bryant and Storer, *Game Birds of California*, 570. Ober, *California Fish and Game*, VI, 14, 1920.

Family PHASIANIDÆ. *Pheasants*

Ring-necked Pheasant (*Phasianus torquatus*); its economic status depends upon local conditions; harmful to truck gardens and field crops in certain localities, at certain seasons and under certain conditions; neutral or useful in other localities, at other seasons and under different conditions. Twelve stomachs, autumn and winter, Oregon and Washington; oats and wheat, 34%, largely waste grain; next in importance, March flies, 1 containing 360, another 432; 1 contained 8,000 chickweed seeds; another, 200 pine seeds.[30] Takes all the common insect pests of garden and field; 3 in captivity, 5 weeks old, ate between 250 and 300 house flies in ½ hour; birds shot while apparently damaging garden and farm crops contained grain, 20%; tomatoes, 21%; insects, 15%; weed seeds, 23%; balance, undeterminable.[31] Of 48 Colorado specimens, 28 contained an average of 197.1 grains of wheat each; 6 averaged 105.4 grains of barley; 8 averaged 65.6 grains of corn; 6 averaged 67 grains of oats; total of all the grains in all the birds averaged 146.6 kernels, probably only ½ a day's ration; 28 contained 2,127 weed seeds, the largest item being sunflowers; insects for all the birds, 788 (injurious, 628, chiefly alfalfa webworms; beneficial, 2; neutral, 158); 1 contained 335 webworms; another, 222; only 7 grasshoppers and 3 cutworms in all; 12 other specimens examined by Maxson contained 18 grasshoppers and no cutworms, but a larger percentage of weed seeds.[32]

English Pheasant; 2 stomachs, British Columbia; oats and wheat, 82.5%, mostly waste grain.[33]

Guinea Hen (*Numida meleagris*); introduced into Porto Rico, where it now runs wild; food consists of seeds, wild fruit, maize, rice, sweet potatoes and plantain; damages sweet potato crops.[34]

[30] McAtee and Beal, *Farmers' Bull.* 497, 14, 1912.
[31] Grinnell, Bryant and Storer, *Game Birds of California*, 575, 1918.
[32] Burnett and Maxson, Office of State Entom., Colo. Agric. College, *Circular* 31, 1921. [33] McAtee and Beal, *Farmers' Bull.* 497, 14, 1912.
[34] Wetmore, *U. S. Dept. Agric., Bull.* 326, 34, 1916.

ORDER COLUMBÆ. PIGEONS AND DOVES

Family COLUMBIDÆ. *Pigeons and Doves*

The birds of this order are largely vegetarian, chiefly gramnivorous,[1] but some species, if not all, add insects to their diet when they are abundant.

Band-tailed Pigeon (*Columba fasciata fasciata*); food chiefly wild berries and nuts; of 22 food records, 10 mention acorns as part of its diet; sometimes resorts to grain fields and does some damage,[2] but probably not much, as most of the grain taken is waste grain from the surface, not seed or sprouts scratched or pulled up, according to Barnes.[3] In New Mexico, feeds almost exclusively on acorns in winter.[4]

White-crowned Pigeon (*C. leucocephala*); 5 stomachs, Porto Rico; food wholly wild fruits, mostly of 6 species.[5] Scaled Pigeon (*C. squamosa*); food entirely wild berries and fruit, with an occasional leaf or bit of herbage; 11 species of plants taken.[6]

Passenger Pigeon (*Ectopistes migratorius*); this beautiful bird, once abundant in several states, has recently become extinct because of its ruthless slaughter for the market; food during most of the year, nuts, grain and seeds of weeds and grasses; during nesting season, fed largely on animal matter, especially earthworms, grubs and insects; fond of salt, and was killed in large numbers about the salt licks.[7] Six Nebraska stomachs averaged 8 locusts and 2 other insects, with

[1] Wetmore, *U. S. Dept. Agric., Bull.* 326, 50, 1916.
[2] Grinnell, Bryant and Storer, *Game Birds of California*, 584-586, 1918.
[3] Barnes, *California Fish and Game*, II, 212, 1916.
[4] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 50, 1901.
[5] Wetmore, *U. S. Dept. Agric., Bull.* 326, 53, 1916.
[6] Wetmore, *ibid.*, 54.
[7] Barrows, *Michigan Bird Life*, 242, 1912.
[8] Aughey, 1st Rept. *U. S. Entom. Comm.*, 46, 1878.

seeds.[8] In relaxing 2 old skins, 1 was found to contain the bones and dried flesh, with the crop full of food, consisting of 25 maple seeds.[9]

Mourning Dove (*Zenaidura macroura caurinus*); "preeminently a seed eater"; weed seeds 64% of its diet; sometimes turns to grain; 1 contained 7,500 wood sorrel seeds; another, 6,400 foxtail grass seeds.[10] One contained 9,200 bindweed seeds; another 3,108 weed seeds; 4, only weed seeds; a little corn in 2.[11] When one remembers that each seed is a prospective weed, that the figures quoted in each instance represent only 1 meal for the bird, and the number of birds engaged in eating weed seeds, their value in this respect is evident. Six Nebraska stomachs contained 9 locusts, 21 other insects and 346 seeds.[12] One from a canker-infested orchard; corn, 75%; balance leguminous plant seeds.[13] In 237 stomachs, vegetable matter, 99%, chiefly seeds and grain; weed seeds, 64%; 150 contained wheat, oats, rye, corn, barley and buckwheat, 32%, ¾ of which was waste grain taken after harvest; 1 contained 4,800 seeds of orange hawkweed, 2,600 of slender paspalum, 620 of panic grass, 50 of wood sorrel and 40 of other seeds.[14]

Porto Rican Dove (*Z. zenaida lucida*); 22 stomachs, Porto Rico; food vegetable matter, except in 4 (a snail and a few insects, 0.36% of total food); seeds, largely of injurious weeds, comprise most of diet, with a few leaves and a little grain; includes seeds and fruits of 33 species of plants.[15]

Ground Dove (*Chæmepelia passerina passerina*); all Florida stomachs examined by Baker contained seeds and other vegetable matter.[16] Mona Ground Dove (*C. p. exigua*); habits

[9] Bishop, *Auk*, XLI, 154, 1924.
[10] Judd. *Yearbook U. S. Dept. Agric. for* 1898, 231-232. Dutcher, Nat. Assn. Audubon Societies, *Educ. Leaflet No.* 2. *Farmers' Bull.* 513, 28, 1913.
[11] Sullivan, *Economic Value of Bird Life*, 32, 1912.
[12] Aughey, 1st Rept. *U. S. Entom. Comm.*, 46, 1878.
[13] Forbes, *Bull. Illinois State Lab. Nat. Hist.*, I, No. 6, 16, 1883.
[14] *Farmers' Bull.* 513, 28, 1913.
[15] Wetmore, *U. S. Dept. Agric., Bull.* 326, 52, 1916.
[16] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1889.

doubtless same as next species.[17] Porto Rican Ground Dove (*C. p. trochili*); 72 stomachs, Porto Rico; animal matter, only 0.25%; fruits and seeds, 99.75% (weed seeds, 25%; wild fruit, 3.4%); 1 contained 9,000 purslane seeds; another, 5,000; 1, 2,400 Egyptian grass seeds; another, 1,450; does no harm, but some good in the destruction of pernicious weed seeds.[18]

Ruddy Quail-Dove (*Oreopepleia montana*); 5 stomachs, Porto Rico; vegetable matter only, except 1 ant; during orange season, feeds largely on seeds of oranges from decayed fruit beneath the trees; 1 contained 17, another 13 of these seeds; stomachs also contained seeds of grass, spurge, madder and myrtle; feeds also on manchineel, which is very poisonous to human beings.[19]

Nutmeg Pigeon (*Globicera pacifica*); Polynesia; fitted with a highly specialized gizzard, adapted to grinding nutmegs, upon which it feeds to a large extent, whence its popular name.[20]

[17] Wetmore, *U. S. Dept. Agric., Bull.* 326, 51-52, 1916.
[18] Wetmore, *ibid.*, 50-51.
[19] Wetmore, *ibid.*, 48.
[20] Wood, *Auk*, XLI, 433-438, 1924.

ORDER RAPTORES. BIRDS OF PREY

The Birds of Prey are flesh eaters, usually provided with strong talons for seizing and holding their prey and strong, hooked beaks for tearing the flesh. They have been more persecuted than any other group of birds, under the mistaken impression that they are all enemies of poultry. The majority of men and boys still consider the killing of Hawks, Owls and Eagles a patriotic service, as well as a mark of skill. Since the masterly studies of the habits of birds of this order by Fisher and others, there is no longer excuse for ignorance of the usefulness of most of the species. Only a few of the 73 species and subspecies recognized in the United States when Fisher's reports were published are considered possibly or probably more harmful than useful, namely: The Gyrfalcons, Duck Hawk, Sharpshinned and Cooper Hawks, Goshawk and Great Horned Owl. In many states the other species are all now protected by law, and do a vast amount of good in the extermination of mammal and other pests.[1] Of the species not enumerated as harmful, 2,212 stomachs were examined as a basis for Fisher's reports; 56% contained mice and other small mammals; 27%, insects; only 3.5% contained poultry or game birds.[2]

Under the bounty act of 1885, the State of Pennsylvania paid $90,000 in bounties on Hawks and Owls in a year and a half. Merriam estimated the total value of poultry taken by Birds of Prey during such a period to be $1,875. Hence

[1] Fisher, "The Hawks and Owls of the United States in their Relation to Agriculture," *U. S. Dept. Agric., Div. of Orn. and Mam., Bull.* 3, 1893, 201 pages; "Hawks and Owls from the Standpoint of the Farmer," *Yearbook U. S. Dept. Agric. for* 1894, 215-232 (revised and republished as *U. S. Biol. Surv. Circular* 61, 1907. Oberholser, "The North American Eagles and their Economic Relations," *U. S. Biol. Surv., Bull.* 27, 1900. Judd, *Yearbook U. S. Dept. Agric. for* 1900, 428.

[2] Fisher, *Bull.* 3, 17, 1893.

it cost the state $90,000 to save less than $2,000. Furthermore, he estimated the value of the Hawks and Owls to the state at an average of $20 per annum as enemies of mice and insects, and that the damage to the state from the destruction of the Hawks and Owls was $3,850,000, in addition to the amount paid in bounties.[3] Campaigns against Hawks destroy more useful than harmful species, because they are slower and less elusive than the harmful ones.[3a]

Nine species of Hawks and 3 of Owls are known to feed freely on ground squirrels;[4] 2 of Hawks and 3 of Owls prey upon pocket gophers;[5] 8 species of Birds of Prey are listed as enemies of jack rabbits;[6] 4 of Owls and 7 of Hawks are mentioned as enemies of the brown rat.[7] Bailey and Piper have discussed the Hawks and Owls as enemies of mice during the great plague of mice in Nevada.[8] The destruction of Hawks and Owls has repeatedly been followed by plagues of voles, while, on the other hand, Birds of Prey have often been known to flock to fields infested with mice and to aid in their suppression. It is estimated that they destroyed 1,500,000 mice each month during the great Nevada outbreak.[9] A great increase in the number of rabbits in eastern Massachusetts was followed next winter by the appearance of Great Horned Owls in unusual numbers, the birds feeding upon the rabbits.[10] In Canada the Goshawk, Golden and Bald Eagles and Great Horned Owl are very destructive to snowshoe rab-

[3] Forbush, *Mass. State Board Agric., Bull.* 9, 61, 1921.

[3a] McAtee, *Awk*, XLIII, 542-545, 1926.

[4] Bailey, "The Prairie Ground Squirrels or Spermophiles in the Mississippi Valley," *Div. Orn. and Mam., Bull.* 4, 1893.

[5] Bailey, "The Pocket Gophers of the United States," *U. S. Div. Orn. and Mam., Bull.* 5, 1893.

[6] Palmer, "The Jack Rabbits of the United States," *Div. Orn. and Mam., Bull.* 8, 1896.

[7] Lantz, "The Brown Rat in the United States," *U. S. Biol. Surv., Bull.* 33, 1909.

[8] Bailey, *Farmers' Bull.* 335, 1908. Piper, "The Nevada Mouse Plague of 1907-8," *U. S. Dept. Agric., Farmers' Bull.* 352, 1909; "Mouse Plagues, their Prevention and Control," *Yearbook U. S. Dept. Agric. for* 1908, 301-310.

[9] Forbush, *Mass. Dept. Agric., Bull.* 9, 49-53, 1921. Allen, *Cornell Reading Courses*, IV, No. 76, 27-29, 1914. Piper, *Yearbook U. S. Dept. Agric. for* 1908, 302-304.

[10] Beal, *Yearbook U. S. Dept. Agric. for* 1900, 300.

bits.[11] In California the food of Hawks and Owls is chiefly rodents and the larger insects.[12]

The following table has been compiled from Fisher's reports,[13] to show what proportionate number of stomachs of these birds of various species (throwing the subspecies of each species together) contained the kinds of food enumerated:

	Total number of stomachs examined	Poultry and Game Birds	Other Birds	Mice	Other mammals	Reptiles	Amphibians	Fish	Insects	Molluscs and Crustaceans	Carrion and Offal	Empty
Swallow-tailed Kite	6	..	..	..	..	2	1	..	6	..	..	..
White-tailed Kite	1	..	..	1	..	..	..	..	..	..	..	..
Mississippi Kite	4	..	..	..	..	..	..	..	4	..	..	..
Marsh Hawk	124	7	34	57	22	7	2	..	14	..	..	8
Sharp-shinned Hawk	159	6	99	6	..	..	..	..	5	..	..	52
Cooper's Hawk	133	34	52	..	11	3	1	..	2	..	..	39
Goshawk	28	9	2	..	10	..	..	..	3	..	..	8
Harris' Hawk	6	..	..	..	5	..	..	..	1	..	..	1
Red-tailed Hawk	562	54	51	278	131	37	..	3	47	8	13	89
Red-shouldered Hawk	220	3	12	104	40	20	39	..	92	7	2	14
Zone-tailed Hawk	5	..	..	..	..	2	3	1	..	..	..	1
Swainson's Hawk	18	..	..	..	7	3	3	..	8	..	..	3
Broad-winged Hawk	65	..	2	15	13	11	13	..	30	4	..	7
Mexican Black Hawk	6	..	..	..	..	1	3	2	..	..	..	..
Roughleg Hawk	49	..	..	40	5	1	..	..	1	..	..	4
Ferruginous Roughleg	1	..	..	..	1	..	..	..	..	..	..	..
Golden Eagle	6	..	1	..	2	..	..	..	..	..	2	1
Bald Eagle	21	1	..	..	5	..	..	9	..	..	2	5
Prairie Falcon	11	3	5	..	2	..	..	..	2	..	..	3
Duck Hawk	20	7	9	1	..	..	..	..	2	..	..	4
Pigeon Hawk	56	3	41	2	..	..	..	..	16	..	..	5
Richardson's Merlin	4	..	2	..	..	..	..	..	1	..	..	1
Sparrow Hawk	320	1	53	89	12	12	..	..	215	..	..	29
Audubon's Caracara	2	..	..	..	1	..	..	..	..	..	1	..
Osprey	12	..	..	..	..	..	..	11	..	..	..	1
Barn Owl	39	1	3	17	17	..	..	..	4	..	..	7
Long-eared Owl	107	1	15	84	5	..	..	..	1	..	..	15
Short-eared Owl	101	..	11	77	7	..	..	..	7	..	..	14
Barred Owl	109	5	13	46	18	..	4	2	14	9	..	20
Great Gray Owl	9	..	1	7	4	..	..	..	..	..	..	..
Saw-whet Owl	22	..	1	17	..	..	..	..	1	..	..	3
Screech Owl	255	1	38	91	11	..	4	1	100	9	..	43
Flammulated Owl	2	..	..	..	..	..	..	..	2	..	..	..
Great-horned Owl	127	31	8	13	65	..	..	1	10	..	..	17
Snowy Owl	38	2	9	18	2	..	..	..	..	..	..	12
Hawk Owl	1	..	..	1	..	..	..	..	..	..	..	..
Burrowing Owl	32	..	..	..	3	..	..	..	30	..	..	1
Pygmy Owl	6	..	1	1	..	..	..	..	1	..	..	2
Elf Owl	3	..	..	..	1	..	..	..	3	..	..	..

[11] Auk, XXXV, 372, 1918; citing *Agric. Gaz. Canada*, IV, No. 41, 1917.

[12] Bryant, "Evidence on the Food of Hawks and Owls in California," *Condor*, XX, 126-127, 1918; "Miscellaneous Stomach Examinations," *Condor*, XXI, 127, 1919.

[13] Fisher, *Div. Orn. and Man., Bull.* 3, 1893; *Yearbook U. S. Dept. Agric. for* 1894, 215-232. Reprinted from Henderson, *Univ. Colo., Extension Div., Bull.* 7, 1913.

From statistics in Aughey's report on the food of Nebraska birds the average number of insects contained in the stomachs examined by him has been computed and tabulated as follows: [14]

	Number of stomachs	Average number of locusts	Average number of other insects	Other food
Swallow-tailed Kite	3	43	27	.....
Marsh Hawk	6	41	26	Reptiles and gopher
Prairie Falcon	1	16	..	.....
Richardson's Merlin	2	12	..	.....
Sparrow Hawk	10	5	31	Mammals, birds, frog
Red-tailed Hawk	1	..	37	Quail
Swainson's Hawk	4	32	31	Gophers, rabbit, mouse
Rough-leg	1	..	70	Lizard, gopher
Barn Owl	3	13	39	Mice
Great-horned Owl	1	..	30	Gopher
Screech Owl	8	27	27	Mice, bird
Short-eared Owl	2	15	8	Gopher, rabbit
Burrowing Owl	9	35	23	Mouse, lizard, prairiedog
Snowy Owl	4	..	3	Quail, grouse, rabbit

Family Cathartidæ. *American Vultures*

These birds, including the Vultures and Condors, are very useful as scavengers, feeding chiefly on carrion. The California Condor has been hunted for its plumes and eggs and nearly exterminated.[15] The Turkey Vulture, commonly called "Turkey Buzzard" (*Cathartes aura septentrionalis*); in addition to its principal food (carrion), takes also some snakes, toads, rats, mice and occasionally young birds.[16] One young bird, "before it had a single feather," ate a house snake 3½ feet long, its weight equal to ⅕ that of the bird, and completely digested it in 1½ hours.[17]

Family Accipitridæ. *Hawks, Eagles, Kites, etc.*

Swallow-tailed Kite (*Elanoides fortificatus*); feeds on reptiles, frogs and insects; 1 contained 6 snakes (one 22½ inches

[14] Aughey, 1st Rept. *U. S. Entom. Com.*, 42-45, 1878. Table reprinted from Henderson, Univ. Colo., *Extension Div., Bull.* 7, 1913.
[15] *Bird-Lore*, XIX, 5-8, 1917.
[16] Barrows, *Michigan Bird Life*, 256, 1912. Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1899.
[17] Roddy, *Auk*, V, 245, 1888.

long), with larvæ and beetles; another, a 19-inch snake, 6 lizards, 4 beetles, 2 reptile eggs (Audubon).[18] White-tailed Kite (*Elanus leucurus*); food, reptiles, frogs, insects and mice; Audubon found bird remains in 2 stomachs.[19] Mississippi Kite (*Ictinia mississippiensis*); takes many insects; 1 contained beetles (Wilson); 1 crammed with beetles and katydids (Coues); 4 contained only insects; expert in catching grasshoppers (Nelson); not known to take birds or mammals.[20] Everglade Kite (*Rostrhamus sociabilis*); feet and bill especially adapted to holding and feeding upon large snails, hence sometimes called the "Snail Hawk"; in Florida *Ampullaria depressa* constitutes a large part of its food.[21] Five stomachs of both young and old; food entirely snails.[22]

Marsh Hawk (*Circus hudsonius*); favorite diet meadow mice, gophers, squirrels and young rabbits, but also takes frogs, lizards, snakes, insects and small birds.[23] Of 14 stomachs, 7 contained only field mice; 3, frogs; 2, Warblers; 1, Sparrow feathers and insects; 1, grasshoppers and rabbit hair.[24] One killed 7 Hungarian Partridges out of a flock of 14 in 2 weeks in January.[25] Stomachs from Pyramid Lake, Nevada, were packed full of lizards, with nothing else, though individuals were observed chasing Sparrows.[26]

Sharp-shinned Hawk (*Accipiter velox*); this small Hawk is one of our most destructive American species; food very largely wild birds and young poultry; as early as 1893 it was known to take at least 50 species of birds, many of them insectivorous; mammals and insects, mostly mice and grass-

[18] Fisher, *Div. Orn. and Mam., Bull.* 3, 20-21, 1893.
[19] Fisher, *ibid.*, 23.
[20] Fisher, *ibid.*, 24-25.
[21] Fisher, *ibid.*, 25-26. Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1889. Lang, *The Nautilus*, XXXVII, 73-77, 1924.
[22] Nicholson, *Auk*, LXIII, 66, 1926.
[23] Fisher, *Yearbook U. S. Dept. Agric. for* 1894, 220; *Div. Orn. and Mam., Bull.* 3, 26-28, 1893. Henshaw, *Rept. U. S. Geog. and Geol. Surv. and Explor. W. of 100th Meridian*, V, 416, 1875. Coues, *Birds of the Northwest*, 331, 1874.
[24] Warren, *Birds of Pennsylvania*, 75; cited by Fisher.
[25] Coale, *Auk*, XLII, 269, 1925.
[26] Ridgway, *Rept. Geol. Explor. 40th Parallel* (King Survey), IV, 580, 1877.

hoppers, rarely taken; of 107 stomachs, 103 (96.25%) contained remains of birds.[27] Porto Rican Sharp-shinned Hawk (*A. striatus venator*); seen eating small birds in Porto Rico; 1 stomach contained a Vireo and feathers of a Honey Creeper.[28]

Cooper Hawk (*A. cooperi*); "preëminently a Chicken Hawk"; food almost entirely wild birds and poultry, though mammals, reptiles, amphibians and insects have been found in a few; our most destructive species of hawk, because more common than the Goshawk and larger and more common than the Sharp-shinned; even downy young contain bird remains; does a little good locally in the destruction of English Sparrows.[29] A young bird 6 weeks old, in captivity, ate 9 English Sparrows and a house mouse in 1 day, and from then until 10 weeks old averaged 8 Sparrows a day, while a young Broad-winged Hawk (*Buteo platypterus*), not being so voracious, never ate more than 5, usually less.[30]

Goshawk (*Astur atricapillus atricapillus*); feeds chiefly on birds, including poultry and game birds; very destructive; takes some rodents and insects; in Alaska, lemmings constitute a large part of its food; on Yukon River, feeds largely on Ptarmigan.[31]

Harris Hawk (*Parabuteo unicinctus harrisi*); food largely offal, the smaller mammals and reptiles, occasionally birds; of 6 stomachs, 5 contained mammals, 1 insects and 1 was empty.[32] Of 2 other stomachs, 1 contained Green-winged Teal feathers, the other Flicker and other feathers.[33]

[27] Fisher, *Yearbook U. S. Dept. Agric. for* 1894, 232; *Div. Orn. and Mam., Bull.* 3, 32-37, 1893. Lloyd, *Auk*, IV, 188, 1887. Maynard, *Birds of Eastern N. Amer.*, 304, 1880.

[28] Wetmore, *U. S. Dept. Agric., Bull.* 326, 33, 1916.

[29] Fisher, *Yearbook for* 1894, 231-233; *Div. Orn. and Mam., Bull.* 3, 38-43, 1893. Warren, *Birds of Pennsylvania*, 80, 1888. McAtee and Beal, *Farmers' Bull.* 497, 27, 1912. Aughey, 1st Rept. *U. S. Entom. Com.*, 44, 1878. *Farmers' Bull.* 513, 28, 1913.

[30] Roddy, *Auk*, V, 246, 1888. See also Judd, *Yearbook U. S. Dept. Agric. for* 1900, 429.

[31] Fisher, *Yearbook for* 1894, 232; *Div. Orn. and Mam., Bull.* 3, 43-46, 1893. Aughey, *1st Rept. U. S. Entom. Com.*, 44, 1878.

[32] Fisher, *Div. Orn. and Mam., Bull.* 3, 47-48, 1893.

[33] Miller, *Condor*, XXVII, 71-72, 1925.

The genus *Buteo* includes quite a number of species and subspecies of large, slow-moving Hawks, popularly called "Chicken Hawks," but in reality seldom molesting poultry, living to a great extent on destructive mammals, insects, reptiles and amphibians.[34] Red-tailed Hawk, Krider Hawk, Western Red-tail and Harlan Hawk (*B. borealis borealis, B. b. krideri, B. b. calurus, B. b. harlani*); very useful in the destruction of injurious rodents; 85% of their food consists of non-beneficial animals, mostly destructive species; poultry only 10%, taken when rodents are scarce; feeds largely on meadow mice when they are plentiful; grasshoppers, crickets and beetles also taken.[35] Detected feeding on Pigeons in California.[36] One stomach contained a gray squirrel, a 21-inch gartersnake and a 15-inch watersnake.[37] One Red-tail stomach contained remains of a Kingfisher and a field mouse.[38] Of 2 Porto Rico stomachs, 1 was empty, the other contained a rat.[39]

Red-shouldered, Florida Red-shouldered and Red-bellied Hawks (*B. lineatus lineatus, B. l. alleni, B. l. elegans*); diet varied; mice, 65%; poultry, 2%; grasshoppers, crickets, beetles and caterpillars taken freely.[40] The Florida subspecies has been said to feed on squirrels, Meadowlarks, frogs and insects.[41]

Swainson Hawk (*B. swainsoni*); ground squirrels a favorite food; seldom takes wild birds or poultry, but takes more insects than other species of this group; lives largely on grasshoppers in summer and autumn; 300 in 1 stomach; 1 taken at 9 a. m. contained 125 grasshoppers; 500 individuals seen

[34] Lantz, *U. S. Biol. Surv., Bull.* 31, 43, 1907.
[35] Fisher, *Div. Orn. and Mam., Bull.* 3, 50-62, 1893; *Yearbook for* 1894, 221. *Farmers' Bull.* 513, 27, 1913.
[36] Wyman, *Condor*, XXVII, 77-78, 1925.
[37] Spellum, *Oologist*, XXX, 272, 1913.
[38] Snyder, *Auk*, XLIII, 97-98, 1926. Compare Johnson, *Auk*, XLII, 585-586, 1925.
[39] Wetmore, *U. S. Dept. Agric., Bull.* 326, 33, 1916.
[40] Fisher, *Div. Orn. and Mam., Bull.* 3, 62-70, 1893; *Yearbook for* 1894, 221. Lantz, *U. S. Biol. Surv., Bull.* 31, 34, 1907. Bryant, *Condor*, XXIII, 65, 1921.
[41] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1889.

feeding on crickets at Lay, Colorado, in 1889.[42] Takes 200 grasshoppers daily under favorable circumstances.[43] Four stomachs from Salt Lake filled with crickets.[44] Birds shot after midsummer stuffed with grasshoppers.[45] September stomachs from Arizona "were crammed with grasshoppers."[46] On one day 200 were seen feeding on grasshoppers.[47] Saves western farmers $117,000 annually by the destruction of grasshoppers and field mice.[48]

Broad-winged Hawk (*B. platypterus*); food largely insects, small mammals, reptiles, amphibians and occasionally small birds; rarely attacks large birds or poultry; fond of large caterpillars that feed upon leaves of shade and orchard trees; does no damage except in the destruction of some toads and snakes; 1 stomach was gorged with earthworms and 1 with crayfish.[49] White-tailed Hawk (*B. albicaudatus sennetti*); food consists of snakes, frogs, rabbits and birds.[50] European Buzzard (*B. buteo*); 784 stomachs contained 1,124 rodents, nearly all field mice.[51]

Mexican Black Hawk (*Urubitinga anthracina*); feeds chiefly on lower vertebrates; rarely takes birds.[52] Takes many reptiles.[53] Occasionally seen eating fish.[54] One seen eating a Curassow.[55] Takes also small mammals, crustaceans and insects.[56] Mexican Goshawk (*Asturina plagiata*); food

[42] Fisher, *Div. Orn. and Mam., Bull.* 3, 72-79, 1893; *Yearbook for* 1894, 222. Lantz, *U. S. Biol. Surv., Bull.* 31, 43, 1907.
[43] Cooke, *Ann. Rept. Colo. State Board of Horticulture for* 1898, 47.
[44] Ridgway, *Rept. Geol. Explor. 40th Par.*, IV, 585-587, 1877.
[45] Coues, *Amer. Nat.*, VIII, 285-286, 1874.
[46] Henshaw, *Rept. Geog. and Geol. Explor. W. of 100th Merid.*, V, 422, 1875.
[47] Merriam, *Forest and Stream*, Dec. 27, 1888, 455.
[48] Forbush, *Mass. Dept. Agric., Bull.* 9, 61, 1915; citing Rept. on work of U. S. Biol. Surv., U. S. Senate Doc. 132, 1907, 16th Cong., 1st Sess.
[49] Fisher, *Div. Orn. and Mam., Bull.* 3, 78-83, 1893; *Yearbook U. S. Dept. Agric. for* 1894, 222. Lantz, *U. S. Biol. Surv., Bull.* 31, 43, 1907. Warren, *Birds of Pennsylvania*, 91, 1888.
[50] Fisher, Bull. 3, p. 72; citing *Ornith. and Ool.*, VII, 68, 1887.
[51] Lantz, *U. S. Biol. Surv., Bull.* 31, 44, 1907.
[52] Fisher, *Bull.* 3, 84-85.
[53] Nutting, *Proc. U. S. Nat. Museum*, V, 404, 1892.
[54] Mearns, *Auk*, III, 72, 1886.
[55] Ridgway, *Proc. U. S. Nat. Museum*, VIII, 581, 1885.
[56] Lawrence, *U. S. Nat. Museum, Bull.* 4, 42, 1875.

chiefly mice, but takes many birds; also ground squirrels and insects.[57]

European Rough-legged Hawk (*Archibuteo lagopus lagopus*); 250 stomachs contained 879 rodents, mostly field mice; 94% had eaten injurious rodents.[58] American Rough-legged Hawk (*A. l. sanctijohannis*); food almost exclusively rodents, chiefly mice; seldom or never takes poultry or other birds; many stomachs from Connecticut examined and all contained meadow mice; in the North, staple diet is lemmings.[59] It takes also frogs.[60] In 28 stomachs there were 128 harmful rodents (98 field mice, 1 gopher, 4 house mice, 4 white-footed mice, 2 rabbits, 19 not specifically determined), 1 weasel, 1 shrew, 1 lizard, 70 insects, no bird remains; 5 or 6 field mice each in several and 12 in 1.[61] Of 32 stomachs, 1 contained a frog, 1 a muskrat, 1 filled with grasshoppers, the rest nothing but mice; 1 contained 7 whole mice.[62] Eleven from Utah all contained mice.[63] Ferruginous Rough-leg (*A. ferrugineus*); food almost entirely small mammals, especially mice, and, in the North, lemmings; takes also rabbits, squirrels, pocket gophers and reptiles; almost never takes birds.[64] In California it feeds extensively on ground squirrels.[65] One stomach contained 7 meadow mice.[66]

Bat-eating Hawk (*Machraerhampus andersoni*); Africa; structurally and otherwise adapted to feeding on bats; 9 stomachs; 2 empty; 7 contained 11 bats and 10 birds, half the birds from 1 stomach.[67]

[57] Fisher, *Bull.* 3, 85-86. Bendire, *Ornith. and Oologist*, VI, 88, 1882. Brewster, *Bull. Nuttall Orn. Club*, VIII, 31, 1883.
[58] Lantz, *U. S. Biol. Surv., Bull.* 3, 44, 1907.
[59] Fisher, *Bull.* 3, 86-90; *Yearbook for* 1894, 219-220. Lantz, *U. S. Biol. Surv., Bull.* 31, 44, 1907.
[60] Hall, *Forest and Stream*, XX, 284, 1883.
[61] Beal, Yearbook *U. S. Dept. Agric. for* 1900, 301. McAtee and Beal, *Farmers' Bull.* 497, 28, 1912.
[62] Nash, *Birds of Ontario in Relation to Agriculture*, 5, 1898.
[63] Henshaw, *U. S. Geog. and Geol. Explor. and Surv. W. of 100th Merid.* (Wheeler Survey), V, 426, 1875.
[64] Fisher, *Bull.* 3, 91-93; *Yearbook for* 1894, 219-220.
[65] Coues, *Birds of the Northwest*, 366, 1874.
[66] Bryant, *Condor*, XV, 92, 1913.
[67] *Bull. Amer. Museum of Nat. Hist.*, XXXVII, 551-552, 1917.

The beneficial and pernicious habits of the Bald and Golden Eagles (*Haliæëtus leucocephalus leucocephalus, Aquila chrysætus*) are about balanced; useful where rabbits, squirrels, prairie dogs, etc., are abundant and there is no poultry; destroy some fawns, young stock, poultry and game birds; feed to some extent on carrion.[68] The Golden Eagle takes also snakes, even "numbers of rattlesnakes"; in captivity, eats 2 pounds of meat daily.[69] The Bald Eagle feeds largely on dead fish; otherwise food similar to that of the Golden Eagle.[70] Gray Sea Eagle (*Haliæëtus albicilla*); feeds chiefly on fishes; next in importance, birds; takes some poultry and small mammals.[71]

Family Falconidæ. *Falcons, Caracaras, etc.*

Gray Gyrfalcon (*Falco rusticolus rusticolus*); 5 stomachs; 4 contained field mice; the other, remains of a Gull.[72] Prairie Falcon (*F. mexicanus*); good and bad habits about balanced; takes game birds and also pernicious rodents.[73] In California its food is chiefly birds; seldom takes mammals.[74] Duck Hawk (*F. peregrinus*); harmful to water birds and poultry; takes also small birds; feeds to some extent on insects and mice, but on the whole more harmful than useful.[75]

Pigeon Hawk and Richardson Merlin (*F. columbarius columbarius, F. c. richardsoni*); good and bad habits balanced; take birds, insects and injurious mammals.[76] Six

[68] Fisher, *Yearbook for* 1894, 217, 227-228. Judd, *U. S. Biol. Surv., Bull.* 17, 53, 1902.
[69] Oberholser, "The North American Eagles and their Economic Relations," *U. S. Biol. Surv., Bull.* 27, 20-31, 1906.
[70] Oberholser, *ibid.*, 6-13. Allen, *Cornell Reading Courses*, IV, No. 76, 1914.
[71] Oberholser, *ibid.*, 18-20.
[72] Fisher, Yearbook *U. S. Dept. Agric. for* 1894, 229-230; *U. S. Div. Orn. and Mam., Bull.* 3, 102, 1893. Stejneger, *U. S. Natl. Museum, Bull.* 29, 203.
[73] Fisher, *Yearbook for* 1894, 228-229. Jewett, *Condor*, XXVIII, 98, 1926.
[74] Tyler, *Condor*, XXV, 91-92, 1923.
[75] Fisher, *Yearbook for* 1894, 230. Lantz, *U. S. Biol. Surv., Bull.* 31, 44, 1907.
[76] Fisher, *Yearbook for* 1894, 228.

Nebraska stomachs of the former contained birds and some insects; 2 of the latter each contained 12 insects and some bird remains.[77] In Porto Rico the Pigeon Hawk feeds chiefly on small birds.[78] Aplomado Falcon (*F. fusco cærulescens*); food probably about same as that of Prairie Falcon.[79]

Sparrow Hawk (*F. sparverius sparverius*); on the whole a very useful bird; 410 stomachs; 314 contained insects; 129, small mammals; 70, small birds; mice and shrews, 25%.[80] A California stomach was "jam full" of grasshoppers.[81] Food in summer chiefly insects; in winter, mice; occasionally wild birds or young chickens.[82] Two Florida stomachs contained Warbler and Phoebe remains, frog and insects.[83] Porto Rican Sparrow Hawk (*F. s. loquacula*); 48 stomachs, Porto Rico; animal matter, 99.68% (mole crickets, 28.69; other Orthoptera, mainly locusts and katydids, 20.86; bird remains, 1.88, found in only 2; house mice, 5.59; lizards, 40.4, mostly of an abundant species; miscellaneous, 2.25, largely spiders).[84]

Family Pandionidæ. *Ospreys*

American Osprey (*Pandion haliætus carolinesis*); lives almost entirely on fish; not abundant enough to do much damage.[85]

Family Auluconidæ. *Barn Owls*

American Barn Owl (*Tyto alba pratincola*); a very useful bird; food almost entirely mammals, a few insects and occasionally a bird; 200 pellets yielded skulls of 225 meadow mice, 2 pine mice, 179 house mice, 20 rats, 6 jumping mice,

[77] Aughey, 1st Rept. *U. S. Entom. Com.*, 44, 1878.
[78] Wetmore, *U. S. Dept. Agric., Bull.* 326, 32, 1916.
[79] Fisher, *Yearbook for* 1894, 228; *Div. Orn. and Mam., Bull.* 3, 115, 1893.
[80] *Farmers' Bull.* 513, 27, 1913. See also Fisher, *Bull.* 3, 127. Lantz, *U. S. Biol. Surv., Bull.* 31, 45, 1907. Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 47-48.
[81] Mailliard, *Condor*, XXVI, 35, 1914.
[82] McAtee and Beal, *Farmers' Bull.* 497, 29, 1912.
[83] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1889.
[84] Wetmore, *U. S. Dept. Agric., Bull.* 326, 31, 1916.
[85] Wetmore, *ibid.*, 34. Allen, *Cornell Reading Courses*, IV, No. 76, 1914.

20 shrews, 1 mole, 1 Vesper Sparrow.[86] In 675 pellets there were 1,789 mammals (1,119 meadow mice), 36 birds, 2 frogs.[87] From a tower at Smithsonian Institution in Washington, 1,247 pellets yielded 3,100 skulls (field mice, 1,987; house mice, 656; rats, 210; birds, 92, mostly Sparrows and Blackbirds; frogs, 4; total mammals, 97%; birds, 3%).[88] One nest contained 5 pocket gophers, 5 kangaroo rats, 1 pocket mouse, 2 white-footed mice; while 68 California pellets yielded 123 meadow mice, 37 white-footed mice, 24 harvest mice, 7 pocket gophers, 6 shrews, 1 mole, 1 pocket mouse, 13 Jerusalem crickets, with flicker wings beneath the nest.[89] In 56 pellets there were 2 shrews, 65 rice rats, 1 cotton rat, 7 Blackbirds, 12 Sora Rails, 4 Clapper Rails.[89a] Barn Owl (*Tyto alba*); in 1863, 703 pellets from Germany yielded 16 bats, 693 moles, 933 rodents, 1,479 shrews, 22 small birds (19 were Sparrows); 360 later pellets, making 1,063 in all, with a total of 2,151 insectivorous mammals and 1,801 rodents (1,284 voles); in 1874, 6,512 pellets from Bavaria yielded 4,210 shrews and 14,790 rodents (9,046 field mice); Watson has estimated that each pair, while feeding young, captures 40 mice daily; Newman says each Owl of this species is worth 5 pounds annually to the British nation.[90] The bat and shrew items do not constitute a good record, but it is offset by the rodent item. The discrepancy between the relative numbers of insectivorous mammals and rodents taken in different regions may perhaps be due to the fact that the former is proportionately more abundant in some regions.

Family Strigidæ. *Horned Owls, etc.*

American Long-eared Owl (*Asio wilsonianus*); very useful; out of 92 stomachs, 86 contained mice; 150 pellets contained

[86] Fisher, Yearbook *U. S. Dept. Agric. for* 1894, 223-224.
[87] Beal, Yearbook *U. S. Dept. Agric. for* 1900, 301. Lantz, *U. S. Biol. Surv., Bull.* 31, 46, 1907.
[88] *U. S. Dept. Agric., Farmers' Bull.* 513, 4, 26, 1913.
[89] Tyler, *Condor*, XVII, 57, 1915. Foster, *Condor*, XXVIII, 130, 1926. [89a] Townsend, *Auk*, XLIII, 544, 1926.
[90] Lantz, *U. S. Biol. Surv., Bull.* 31, 46-47, 1907.

95 meadow mice, 19 pine mice, 15 house mice, 5 white-footed mice, 3 Cooper mice, 26 shrews, 11 Sparrows, 1 Bluebird, 1 Warbler.[91] One Nebraska stomach contained a few insects and part of a rabbit.[92] Beneath a roosting place of these Owls in Michigan, 110 pellets contained 111 field mice, 8 lemming voles, 4 white-footed mice, 2 shrews, 1 Norway rat.[93]

Short-eared Owl (*A. flammeus*); cosmopolitan; 75% of food consists of mice; 6 found in 1 stomach; has frequently aided in the suppression of vole plagues in Europe; feeds also to some extent on amphibians, reptiles, crustaceans, scorpions and insects; more insectivorous than any of our other Owls except the Burrowing Owl and perhaps the Screech Owl; 1 contained 50 grasshoppers; 1, 18 May beetles; 1, 13 cutworms; of 254 stomachs examined, 15% contained birds; 4.5% of food consists of poultry and game birds; 51 European stomachs contained 90 injurious rodents (76 field mice), and 480 pellets contained 3 beetles, 9 small birds, 7 bank voles, 864 field mice.[94] Three Maryland stomachs, November, contained only field mice.[95] At Toronto, found feeding on birds in September and October; no mice taken.[96] I found 3 skulls of white-footed mice in 1 Colorado stomach. One contained an entire Rail; 2 pellets contained portions of 2 species of bats, 1 field mouse and 3 species of small birds.[97]

Bare-legged Owl (*Asio portoricensus*); 5 stomachs, Porto Rico; Orthoptera, 14%; May beetles, 24.4%; cane-weevil root-borers, 1.8%; other weevils, 1.2%; miscellaneous beetles, 8.4%; Lepidoptera, 7.8%; lizards, 10.8%; birds, 17% (found in only 2 stomachs); Hemiptera, scorpions and other animals, 14.5%.[98]

[91] McAtee and Beal, *Farmers' Bull.* 497, 29, 1912. See also Fisher, *U. S. Div. Orn. and Mam., Bull.* 3, 145, 1893; Yearbook *U. S. Dept. Agric. for* 1894, 224. Lantz, *U. S. Biol. Surv., Bull.* 31, 47, 1907.
[92] Aughey, 1st Rept. *U. S. Entom. Com.*, 42, 1878.
[93] Warthin and VanTyne, *Auk*, XXXIX, 417, 1922.
[94] Fisher, Yearbook *U. S. Dept. Agric. for* 1894, 224-225. Lantz, *U. S. Biol. Surv., Bull.* 31, 48, 1907.
[95] Judd, *U. S. Biol. Surv., Bull.* 17, 86, 1902.
[96] Munro, *Auk*, XXXV, 223, 1918.
[97] Huey, *Auk*, XLIII, 96-97, 1926.
[98] Wetmore, *U. S. Dept. Agric., Bull.* 326, 68, 1916.

Barred Owl (*Strix varia varia*); food chiefly small, destructive rodents; in 100 stomachs, only 4.5% was poultry and game birds.[99] In Nebraska they were seen catching insects on the wing.[100] One in captivity preferred birds and small rodents; took frogs and fish when hungry; ate also insects; digested 2 English Sparrows in 1½ hours.[101] Florida Barred Owl (*S. v. alleni*); food consists of birds, mammals, reptiles and insects.[102]

Great Gray Owl (*Scotiaptex nebulosa nebulosa*); 9 stomachs; 1 contained a bird; 7, mice; 4, other mammals; but Dall reported 1 stomach containing 13 skulls of the Redpoll.[103]

Screech Owl (*Otus asio asio*) and its various subspecies; more insectivorous than any other Owl except the Burrowing Owl and perhaps the Short-eared Owl; of 255 stomachs, 100 contained insects; Sparrows, 15% (5% English Sparrows); 50 grasshoppers in 1; ¾ of food is insects and destructive mammals.[104] Three young and 2 adult stomachs from Maryland contained May beetles and lizards.[105] Of 324 stomachs, 169 contained insects, many of them harmful; 142, small mammals, largely field mice; 56, birds, largely Sparrows; 15, crayfish.[106] Food consists of salamanders, crustaceans, fishes, insects, small birds, rats, snakes, mice; destroys a great many insectivorous birds; economic status in doubt, according to Allen.[107] California Screech Owl (*O. a. bendirei*); noted dead in 1 nest in 12 days, 7 English Sparrows, 1 California Jay, 1 pocket gopher, 2 field mice, 1 salamander, 2 beetles.[108]

[99] Fisher, *Yearbook for* 1894, 225; *U. S. Div. Orn. and Mam., Bull.* 3, 156, 1893. Lantz, *U. S. Biol. Surv., Bull.* 31, 48-49, 1907.
[100] Aughey, 1st Rept. *U. S. Entom. Com.*, 43, 1878.
[101] Roddy, *Auk*, V, 248, 1888.
[102] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1889.
[103] Fisher, *Bull.* 3, 157-158. Lantz, *U. S. Biol. Surv., Bull.* 31, 50, 1907.
[104] Fisher, *Yearbook for* 1894, 225-226; *Bull.* 3, 173. Lantz, *U. S. Biol. Surv., Bull.* 31, 49-50. McAtee and Beal, *Farmers' Bull.* 497, 30, 1912.
[105] Judd, *U. S. Biol. Surv., Bull.* 17, 86, 1902.
[106] *U. S. Dept. Agric., Farmers' Bull.* 513, 26, 1913.
[107] Allen, *Auk*, XLI, 1-16, 1924.
[108] Clabaugh, *Condor*, XXVIII, 43-44, 1926.

Great Horned Owl (*Bubo virginianus virginianus*) and various subspecies; does considerable good where rodents are plentiful and no poultry; feeds mostly at night, so if poultry is kept up and securely protected at night, little damage is done in that direction; takes many wild birds, but favorite food is rabbits; remains of 113 rats in 1 nest.[109] On 16 visits to a nest, there were found 5 Bob-whites, 1 domestic Pigeon, 1 Flicker, 2 Coots, 1 King Rail, 19 adult cottontail rabbits.[110] One owner lost 59 Guinea Hens by this Owl; 1 found with porcupine quills in stomach, intestines, mouth and liver.[111] Rabbits the chief food when abundant, smaller rodents next, with a few birds.[112] Many skunks taken.[113] In Michigan the Western Horned Owl (*B. v. pallescens*) seems to feed mainly on white-footed mice and northern hares.[114] One California stomach of the Pacific Horned Owl (*B. v. pacificus*) contained 2 meadow mice and 27 Jerusalem crickets.[115]

Snowy Owl (*Nyctea nyctea*); food mainly mammals, but some water birds taken.[116] Burrowing Owl (*Speotyto cunicularia cunicularia*); preëminently insectivorous, but takes many scorpions and small mammals, rarely birds.[117] One California stomach obtained during a grasshopper outbreak contained 28 grasshoppers (90% of the food).[118] In South Dakota, when Horned Larks are abundant they are said to constitute 50% of the food of this Owl, the Owl burrows examined containing from 4 to 6 partly-eaten Larks, with a smaller number of field mice.[119]

[109] Fisher, *Yearbook for* 1894, 229. Lantz, *U. S. Biol. Surv., Bull.* 31, 49, 1907. Niles, *Journ. Cincinnati Soc. Nat. Hist.*, VIII, 63.
[110] Keyes, *Condor*, XIII, 5-19, 1911; Smithsonian Inst., *Ann. Rept. for* 1911, 403.
[111] Barrows, *Michigan Bird Life*, 329, 1912.
[112] Pittman, *Bird-Lore*, XXVII, 92-96, 1925.
[113] Wilkinson, *Bird-Lore*, XV, 369, 1913.
[114] Barrows, *Michigan Bird Life*, 331, 1912.
[115] Bryant, *Condor*, XV, 92, 1913.
[116] Fisher, *Yearbook for* 1894, 226. Lantz, *U. S. Biol. Surv., Bull.* 31, 50, 1907.
[117] Fisher, *Yearbook for* 1894, 227.
[118] Bryant, *Univ. Calif. Pub. Zool.*, XI, No. 1, p. 9, 1912.
[119] Patton, *Oologist*, XLIII, 14, 1926.

Pygmy Owl (*Glaucidium gnoma pinicola*); 1 Utah stomach "literally gorged with English Sparrows."[120] One killed a Gambel Quail.[121] Naked-footed Owl (*Gymnasio nudipes*); 2 stomachs, Porto Rico; contained beetles and cockroaches.[122]

[120] Johnson, *Condor*, V, 81, 1903.
[121] Kimball, *Condor*, XXVII, 209, 1925.
[122] Bowdish, *Auk*, XIX, 362-363, 1902.

ORDER PSITTACI. PAROQUETS, MACAWS, PARROTS, ETC.

Family PSITTACIDÆ. *Paroquets, Macaws and Parrots*

Carolina Paroquet (*Conuropsis carolinensis*); food mostly vegetation—fruits, nuts, seeds, grains, nectar, buds and green herbage; fond of cockleburs; in Florida was observed feeding on thistle seeds.[1] Porto Rico Parrot (*Amazona vittata*); entirely frugivorous, taking all kinds of wild fruits in season.[2]

[1] Knowlton, *Birds of the World*, 469-470, 1909.
[2] Wetmore, *U. S. Dept. Agric., Bull.* 326, 56, 1916.

ORDER COCCYGES. CUCKOOS, ETC.

Family Cuculidæ. *Cuckoos, Anis, Etc.*

Ani (*Crotophaga ani*); 41 stomachs, Porto Rico; animal matter, 91.3% (mole crickets, 5.69; other crickets and locusts, 35.8; sugar-cane root-borer, 7.09; leaf beetles, 3.61; other beetles, 4.93; squashbugs, 9.24; other bugs, 1.22; caterpillars, 9.71; spiders, 4.08; miscellaneous animal matter, 1.45; 51 species of insects and arachnids taken, mostly harmful); vegetable matter, 8.7%, mostly seeds and fruits of 7 species of wild plants.[3] Two Porto Rico stomachs were filled with grasshoppers, 50 or more in each.[4]

Roadrunner (*Geococcyx californianus*); the food of this queer bird has been much discussed; on the whole, its habits are good. It takes reptiles, insects, snails, small rodents and young birds.[5] Omnivorous and not harmful, as shown by 83 stomachs from San Diego County, California; beetles, 18.2%; grasshoppers, 21.2%; black crickets, 12.62%; Jerusalem crickets, 3%; Lepidoptera, including hairy caterpillars, 8%; cicadas, 4.3%; Hymenoptera, 4% (1 contained 250 red ants); spiders and scorpions, 0.7%; lizards and snakes, 3.7%; birds, 1.7%.[6] One contained a large horned lizard.[7] One killed a wood rat and a pair cleaned the caterpillars out of the vines about a California home, incidentally taking several chicks, but well paying for them in the good they did.[8] One

[3] Wetmore, *U. S. Dept. Agric., Bull.* 326, 58, 1916.
[4] Bowdish, *Auk*, XIX, 263-264, 1902.
[5] Lantz, *U. S. Biol. Surv., Bull.* 31, 51, 1907. Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 48-49, 1901.
[6] Bryant, *Univ. Calif. Pub. Zool.*, XVII, 21-58, 1916; *Calif. Fish and Game*, I, 195-196, 1915; III, 25-28, 1917; *Condor*, XVI, 105, 1914.
[7] Bryant, *Condor*, XV, 92, 1913.
[8] Anthony, *Auk*, XIII, 257-258, 1896; XIV, 217, 1897.

was caught killing a young Quail,[9] another seen eating young Mockingbirds,[10] while another killed a Golden-crowned Sparrow in a Sparrow trap.[11]

Vieillot Ground Cuckoo (*Coccyzus minor nesiotes*); 15 stomachs, Porto Rico; grasshoppers, 50.31%; caterpillars and moths, 29.52%; cicadas and stinkbugs, 6.09%; walking sticks and a cricket, 3.1%; beetles, mostly weevils, 3.59%; spiders, 4.06%; miscellaneous invertebrates, 1.83%; "one of the most useful birds of the island."[12] One Porto Rico stomach contained 2 lizards, 1 snail and 1 katydid.[13]

Yellow-billed Cuckoo (*C. americanus americanus*); food largely caterpillars, including hairy species not taken by many birds; 109 stomachs contained 1,865 caterpillars, mostly hairy, 242 grasshoppers and 291 other insects and arachnids; 1 contained 250 tent caterpillars; another, 217 fall webworms.[14] One contained more insects, in bulk, than did 522 English Sparrows,[15] yet the latter have locally driven away the Cuckoos. Ten Nebraska stomachs contained 41 locusts and 15 other insects.[16] This species persistently destroyed fall webworms on a Maryland farm, 1 containing 325 larvae.[17] One Porto Rico stomach contained 15 caterpillars of 2 species and 3 sugar-cane root-boring weevils.[18] California Cuckoo (*C. a. occidentalis*); observed feeding on black crickets.[19] Black-billed Cuckoo (*C. erythrophthalmus*); also fond of hairy caterpillars; 46 stomachs contained 906 caterpillars, mostly hairy, and 285 other insects and arachnids.[20] One

[9] Leopold, *Condor*, XXIV, 183, 1922.
[10] Fisher, *Condor*, VI, 80, 1904.
[11] Law, *Condor*, XXV, 133-134, 1923.
[12] Wetmore, *U. S. Dept. Agric., Bull.* 326, 58-59, 1916.
[13] Bowdish, *Auk*, XIX, 364, 1902.
[14] Beal, Yearbook *U. S. Dept. Agric. for* 1900, 297; *Farmers' Bull.* 54, 5-6, 1898; "Food of Cuckoos," *U. S. Biol. Surv., Bull.* 9, 7-14, 1898; *Farmers' Bull.* 630, 27, 1915. *Farmers' Bull.* 513, 25, 1913.
[15] Barrows, *U. S. Div. Orn. and Mam., Bull.* 1, 80, 108, 123, 1889.
[16] Aughey, 1st Rept. *U. S. Entom. Com.*, 40, 1878.
[17] Judd, *U. S. Biol. Surv., Bull.* 17, 28-29, 1902.
[18] Wetmore, *U. S. Dept. Agric., Bull.* 326, 57, 1916.
[19] Cockerell. *N. Mex. Agric. Exper. Sta., Bull.* 37, 49, 1901.
[20] See Beal's papers cited in a preceding footnote. See also Lincoln, *Auk*, XXXVII, 67, 1920.

Nebraska stomach contained 41 locusts.[21] One from a canker-infested orchard in Illinois; cankerworms, 75%; other caterpillars, 20%; vine leaf-chafers, 5%.[22]

Family Trogonidæ. *Trogons*

American Trogons feed chiefly on fruit, taking insects to only a limited extent, while the Old World Trogons subsist largely on insects.[23]

Family Alcedinidæ. *Kingfishers*

Belted Kingfisher (*Ceryle alcyon*); food chiefly fish, in most localities species of no commercial value; also takes crustaceans, insects, amphibians and lizards.[24] One Nebraska stomach contained 18 locusts, with fish remains; another, 14 locusts, with fish.[25] One pair takes 6,000 fish in a season and the species is consequently injurious, according to Sullivan.[26]

Family Motmotidæ. *Motmots and Todies*

Porto Rican Tody (*Todus mexicanus*); 89 stomachs, Porto Rico; earwigs, 9.4%; Orthoptera, 2.28% mostly grasshoppers; Homoptera, 9.28%; other Hemiptera, 1.11%; caterpillars and moths, 5.21%; Diptera, 30.88%; beetles, 23.44%, only 1.59% useful species; snout beetles, 6.47%; leaf beetles, 8.55%; longicorn beetles, 4.87%; Hymenoptera, 4.33%, chiefly useful species; spiders, 8.17%; lizards, 3.52%; seeds, etc., 2.38%.[27]

[21] Aughey, 1st Rept. *U. S. Entom. Com.*, 39, 1878.
[22] Forbes, *Bull. Illinois State Lab. Nat. Hist.*, I, No. 6, 16, 1883.
[23] Knowlton, *Birds of the World*, 572, 1909.
[24] Allen, *Cornell Reading Courses*, IV, No. 76, 1914. Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 50, 1901.
[25] Aughey, 1st Rept. *U. S. Entom. Com.*, 39, 1878.
[26] Sullivan, *Economic Value of Bird Life*, 34, 1912.
[27] Wetmore, *U. S. Dept. Agric., Bull.* 326, 65, 1916. Bowdish, *Auk*, XIX, 364-365, 1902.

ORDER PICI. WOODPECKERS, WRYNECKS, ETC.

Family Picidæ. *Woodpeckers*

Except the Sapsuckers, all the American Woodpeckers are considered beneficial under ordinary circumstances, and some of them are exceedingly useful.[1] Their feet and bills are especially adapted to clinging to the bark of trees and drilling holes in the wood in search of larvæ of wood-boring insects, while the tongues of most of them are capable of great extension and armed with barbs, making them excellent instruments for probing the burrows and extracting the insects.[2]

On an average, 65% of the food of the Woodpeckers of the United States consists of insects, largely ants, caterpillars and beetles, including many species of wood-boring insects that are very injurious to trees and orchard crops, such, for example, as the codling moth.[3] At least half of the spruce-bark beetles of the northeastern United States are said to be eaten by Woodpeckers.[4] One species in the United States is called the Ant-eating Woodpecker, because of its habit of feeding largely on ants. Some species feed extensively on fruits, seeds and buds. In Porto Rico 3 species "subsist on a diet not more than one-third of which is insectivorous."[5] It is known, however, that a considerable part of the fruit taken is wild fruit, and, of the cultivated fruit, much is waste fruit found

[1] See especially: Beal, "Preliminary Report on the Food of Woodpeckers," *U. S. Div. Orn. and Mam., Bull.* 7, 1895; "Birds of California in Relation to the Fruit Industry," Part II, *U. S. Biol. Surv., Bull.* 34, 1910; "Food of the Woodpeckers of the United States," *U. S. Biol. Surv., Bull.* 37, 1911. McAtee, "Woodpeckers in Relation to Trees and Wood Products," *U. S. Biol. Surv., Bull.* 39, 1911.

[2] Allen, *Cornell Reading Courses*, IV, No. 76, 1914. Lucas, "The Tongues of Birds," *Ann. Rept. U. S. Natl. Museum for* 1895, 1001-1020; "The Tongues of Woodpeckers," *U. S. Div. Orn. and Mam., Bull.* 7, 35-44, 1895.

[3] Beal, Yearbook *U. S. Dept. Agric. for* 1908, 343; *U. S. Biol. Surv., Bull.* 34, 14-15, 1910. McAtee, Yearbook *U. S. Dept. Agric. for* 1911, 239.

[4] Hoskins, *U. S. Bur. Entom., Bull.* 28, new series, 23, 25, 26; cited by Beal, *U. S. Biol. Surv., Bull.* 37, 12.

[5] Bowdish, *Auk*, XX, 194, 1903.

| | Number of stomachs | Percentages, omitting fractions | | |

on the ground. Some cambium is found in most of the stomachs and in case of the Sapsuckers it constitutes 23% of the contents of their stomachs.[6]

The table on page 210 has been compiled from Beal's reports on the food of Woodpeckers, subspecies being combined and fractions of percentages omitted for brevity.

In this table one-half of the food of the White-headed Woodpecker consists of pine seeds and ¼ ants. Acorns constitute 53.3% of the food in the California Woodpecker stomachs. The vegetable food of the Ivory-billed Woodpecker consisted of the fruits of magnolia and pecan nuts. The seeds taken by the Harris and Cabanis Woodpeckers were coniferous. At least the following species take noticeable quantities of poison ivy and poison oak seeds: Hairy, Downy, Red-cockaded, Nuttall, Red-headed and Lewis Woodpeckers, Red-shafted Flicker and Yellow-bellied and Red-breasted Sapsuckers. The cambium and rotten wood element in the food of a few of the species is given as follows: American Three-toed Woodpecker, 5%; Arctic Three-toed Woodpecker, 11%; Yellow-bellied, Red-breasted and Williamson Sapsuckers, respectively, 16%, 11% and 12%.

The following table is compiled from Aughey's report[7] on the food of Nebraska birds:

	Number of stomachs	Average number of locusts	Average number of other insects	Other food
Hairy Woodpecker . . .	6	26	32	
Downy Woodpecker . .	4	41	20	
Yellow-bellied Sapsucker	5	26	17	Seeds
Red-bellied Woodpecker	2	..	..	½ locusts, ½ other insects
Red-headed Woodpecker	6	25	35	Grain
Yellow-shafted Flicker .	8	29	23	Grain
Red-shafted Flicker . .	1	18	31	

[6] Beal, *Div. Orn. and Mam., Bull.* 7, 8.
[7] Aughey, 1st Rept. *U. S. Entom. Com.*, 1878.

Ivory-billed Woodpecker (*Campephilus principalis*); 2 stomachs; 32 tree-boring larvæ in 1, 20 in another.[8] Hairy Woodpecker (*Dryobates villosus*); 11 Kansas stomachs; grasshopper eggs, 10%.[9] In Florida its food is largely Coleoptera and caterpillars.[10] This and the Downy Woodpecker "are among our most valuable allies, their food consisting of some of the worst foes of orchard and woodland."[11] Downy Woodpecker (*D. pubescens pubescens*); 11 Kansas stomachs; grasshopper eggs, 10%.[12]

Arctic and American Three-toed Woodpeckers (*Picoides arcticus, P. americanus americanus*); estimated that 1 bird of either species destroys 13,675 wood-boring Coleoptera and Lepidoptera annually.[13]

The Sapsuckers, where they occur in numbers, may do considerable damage to trees, especially in orchard districts.[14] It has been estimated that the Yellow-bellied Sapsucker (*Sphyrapicus varius varius*) does $1,250,000 damage to the lumber industry annually, attacking 250 species of trees.[15] On the other hand it offsets this to a certain extent by destroying large numbers of injurious insects, and during a grasshopper plague in Nebraska the stomachs contained from 15 to 33 grasshoppers each; takes a larger percentage of ants (36%) than any other species except the Flicker.[16] One New Mexico stomach was full of ants; others had fed on ants and beetles.[17]

Pileated Woodpecker (*Phloeotomus pileatus*); 1 stomach

[8] Beal, *U. S. Biol. Surv., Bull.* 37, 62-63, 1911.
[9] Beal, *U. S. Div. Orn. and Mam., Bull.* 7, 11-14, 1895.
[10] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 268, 1889.
[11] *U. S. Dept. Agric., Farmers' Bull.* 513, 25, 1913.
[12] Beal, *U. S. Div. Orn. and Mam., Bull.* 7, 11-14, 1895.
[13] Beal, *U. S. Biol. Surv., Bull.* 37, 25-27. Beal and McAtee, *Farmers' Bull.* 506, 6-7, 1912.
[14] Beal, *Bull.* 37, 27-31; Yearbook *U. S. Dept. Agric. for* 1901, 294-295. Beal and McAtee, *Farmers' Bull.* 506, 12-15. McAtee, *U. S. Biol. Surv., Bull.* 39, 16-99, 1911; *Auk*, XXX, 154-157, 1913. Judd, *U. S. Biol. Surv., Bull.* 17, 88-89, 1902. Forbush, 1st Ann. Rept. *Div. Orn., Mass. Dept. Agric.* (for 1920), 10-23, 1921.
[15] *U. S. Dept. Agric., Farmer's Bull.* 513, 24, 1913.
[16] Beal, *U. S. Div. Orn. and Mam., Bull.* 7, 28-31, 1895.
[17] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 45-46, 1901. Examine also Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 269, 1889.

contained 2,600 ants; another, 2,080.[18] Northern Pileated Woodpecker (*P. p. abieticola*); 1 California stomach contained over 50 carpenter ants and 131 poison oak seeds; 2 from Yosemite each contained over 100 carpenter ants; one contained also fruit of manzanita; the other, 4 large wood-boring beetle larvæ.[19]

Red-headed Woodpecker (*Melanerpes erythrocephalus*); 4 stomachs from a canker-infested orchard, in May; corn, 20%; cankerworms, 15%; carabid beetles, 24%; Scarabæidæ, 29%.[20] Porto Rico Woodpecker (*Melanerpes portoricensis*); 59 stomachs, Porto Rico; animal matter, 65.83% (earwigs, 8.55; Orthoptera, 1.03; wood-boring beetles and larvæ, 24.68; weevils, 1.47; other Coleoptera, 3.99; Hemiptera, 4.16; ants, 10.37, including very destructive species; caterpillars, 2.49; spiders, 1.37; lizards, 6.17; miscellaneous, 1.55); vegetable matter, 34.17% (seeds and small fruits, 24.93; rubbish, mostly bits of wood, 9.24).[21]

Lewis Woodpecker (*Asyndesmus lewisi*); many were found feeding their young on grasshoppers during an outbreak in California.[22] They have been observed flying about over water catching insects on the wing as swallows do.[23] Red-bellied Woodpecker (*Centurus carolinus*); damages oranges locally in the South, but useful elsewhere.[24] Observed also eating waste oranges beneath the trees.[25] In Florida, according to Baker, it feeds chiefly on beetle larvæ, beetles and spiders.[26]

Yellow-shafted Flickers (*Colaptes auratus auratus, C. a.*

[18] Beal, *U. S. Biol. Surv., Bull.* 37, 33-35, 1911. Consult also Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 269, 1889.
[19] Bryant, *Condor*, XVIII, 32, 1916.
[20] Forbes, *Bull. Ill. State. Lab. Nat. Hist.*, I, No. 6, 16, 1883. See also Beal, *Div. Orn. and Mam., Bull.* 7, 20-25, 1895; *Farmers' Bull.* 54, 8, 1898.
[21] Wetmore, *U. S. Dept. Agric., Bull.* 326, 62-63, 1916. See also Bowdish, *Auk*, XIX, 365, 1902; XX, 193-195, 1903.
[22] Williams, *Condor*, VII, 56, 1905.
[23] Marsden, *Condor*, IX, 27, 1907.
[24] Beal, *Yearbook U. S. Dept. Agric. for* 1901, 295.
[25] Brewster, *Auk*, VI, 337-338, 1889.
[26] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 269, 1889.

luteus); more largely terrestrial than most woodpeckers; ants the largest item of food (49%), found in 524 of the 684 stomachs examined; 98 contained nothing else; 1 contained 5,000 ants and 2 others 3,000 ants each; wild fruits next item in importance; 1 contained 28 white grubs.[27] One from a canker-infested orchard contained ants.[28] Red-shafted Flickers (*C. cafer cafer, C. c. collaris*); ants constituted 53% of the food in 183 stomachs examined; found in 127 of the stomachs.[29]

[27] *U. S. Dept. Agric., Farmers' Bull.* 513, 5, 24, 1913. Beal, Yearbook *U. S. Dept. Agric., for* 1900, 294; *U. S. Biol. Surv., Bull.* 37, 52-58, 1911; *Farmers' Bull.* 54, 8, 1898; *U. S. Div. Orn. and Mam., Bull.* 7, 6-20, 1895. Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 269, 1889.

[28] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 16, 1883.

[29] Beal, *U. S. Biol. Surv., Bull.* 37, 59-60, 1911. See also Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 47, 1901.

ORDER MACROCHIRES. GOATSUCKERS, SWIFTS, ETC.

Family Caprimulgidæ. *Goatsuckers, Etc.*

Chuck-will's-widow (*Antrostomus carolinensis*); 2 stomachs, Porto Rico; well filled with insects.[1] One stomach, Porto Rico; food entirely animal matter; May beetles, 15%; balance not definitely determinable.[2] One taken at sea contained remains of a Yellow Warbler, possibly taken because of great hunger and lack of other food;[3] but another, a "plump, fat old female," shot in a marsh where its usual food was abundant, contained an entire Song Sparrow.[4] Whip-poor-will (*A. vociferus vociferus*); 2 Nebraska stomachs; full of locusts.[5] Food chiefly insects. Poor-will (*Phalaenoptilus nuttalli nuttalli*); 1 Nebraska stomach; ⅘ of contents grasshoppers and locusts.[6] Seen in New Mexico catching moths, and birds killed for examination had their throats packed with the moths.[7]

Nighthawk (*Chordeilus virginianus virginianus*); food entirely insects, all or nearly all caught on the wing; 100 stomachs; flying ants in 36; in 24 they ranged from 200 to 1,800 each; 60 grasshoppers in 1, 38 in 1, 22 in 1 and 19 in 1; 34 May beetles in 1, 23 in 1 and 17 in 1; several contained squash beetles and 1 contained 17 species of injurious insects; 87 contained 20,000 flying ants, an average of 230 each, besides

[1] Bowdish, *Auk*, XIX, 365, 1902.
[2] Wetmore, *U. S. Dept. Agric., Bull.* 326, 69, 1916.
[3] Stone, *Auk*, XV, 330, 1898.
[4] Webster, *Auk*, IV, 74, 1887.
[5] Aughey, 1st Rept. *U. S. Entom. Com.*, 38, 1878.
[6] Aughey, *ibid.*, 38.
[7] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 50-51, 1901; citing Shufeldt, per Birtwell, *Auk*, 1885.

other insects.[8] Nearly ¼ of its food is ants and ⅕ belongs to the leaf-chafer family, adults of the white grubs; 1 contained 34 weevils, 375 ants; another, 340 grasshoppers, 52 bugs, 3 beetles, 2 wasps, 1 spider; some contained from 30 to 50 species of insects and altogether more than 600 species have been found in their stomachs, some very destructive.[9] One contained 500 mosquitoes.[10] In the South, 10 stomachs contained cotton-boll weevils and 2 contained 6 weevils each.[11] Seven Nebraska stomachs averaged 51 locusts and 12 other insects each.[12] Takes bill-bugs or "curlew bugs."[13] Though not a member of even the same order as the Hawks, great numbers were at one time killed under a bounty act in Pennsylvania and large sums of money paid in bounties for their destruction as Hawks.[14] Pacific Nighthawk (*C. v. hesperis*); 1 California stomach; 27 beetles, 1 grasshopper, 16 moths, 5 stinkbugs, all injurious species.[15]

Family Micropodidæ. *Swifts*

Chimney Swift (*Chaetura pelagica*); wholly insectivorous, catching its prey on the wing, chiefly the smaller insects such as mosquitoes, gnats and flies.[16] Nebraska stomachs contained locusts, with other insects.[17] Black Swift (*Cypseloides niger borealis*); 6 stomachs; food entirely insects of many species and a few spiders.[18] Jamaican Black Swift (*C. niger jamaicensis*); 2 stomachs, Porto Rico; in 1, ants 91%; the other, ants 45%; balance weevils, flies, etc.[19] The other species of Swifts are equally insectivorous and all are highly beneficial.

[8] Beal, *Natl. Assn. Aud. Soc., Educ. Leaflet* No. 1. Barrows, *Michigan Bird Life*, 378, 1912. Judd, *U. S. Biol. Surv., Bull.* 17, 33, 1902. Sullivan, *Economic Value of Bird Life*, 23, 1912.
[9] Beal, *Farmers' Bull.* 630, 5, 23-25, 1915.
[10] Allen, *Cornell Reading Courses*, IV. No. 76, 1914.
[11] Howell, *U. S. Biol. Surv., Bull.* 25, 13, 1906; *Bull.* 29, 21, 1907.
[12] Aughey, 1st Rept. *U. S. Entom. Com.*, 39, 1878.
[13] Webster, *U. S. Entom. Bur., Bull.* 95, Pt. IV, 1912.
[14] Pennock, Delaware State Board of Agric., *Bull.* 5, 13, 1904.
[15] Bryant, *Condor*, XV, 92, 1913.
[16] Judd, *U. S. Biol. Surv., Bull.* 17, 91, 1902. Pennock, *Delaware State Board of Agric., Bull.* 5, 13, 1904.
[17] Aughey, *U. S. Entom. Com.*, 1st Rept., 39, 1878.
[18] Rathbun, *Auk*, XLII, 515-516, 1925.
[19] Wetmore, *U. S. Dept. Agric., Bull.* 326, 74, 1916.

Family TROCHILIDÆ. *Hummingbirds*

These tiny birds, "glittering fragments of a rainbow," as Audubon called them, are of great esthetic interest and have some good habits. If they destroy a few useful insects, this is offset by the good they do in the pollination of flowers and in the destruction of harmful insects. A considerable part of their food is nectar, but just what proportion is difficult to discover, as it passes through the stomachs more readily and is not so likely to be found in recognizable condition as the hard parts of insects. In 1893 a report on 29 stomachs of 13 species, mostly Ruby-throated, stated that all contained insects, usually in large quantities, mostly small Diptera and Hymenoptera, with some spiders; also take syrup greedily.[20]

Ruby-throated Hummingbird (*Archilocus colubris*); 59 stomachs; vegetable matter, 5.68%; animal matter, 94.32%, largely insects and spiders of uncertain specific identity; Hymenoptera, 36.32%, mostly useful parasitic forms; Hemiptera, 8.88%; many small leaf-hoppers; Diptera, 2.57%, mostly gnats; spiders, 43.46%, neutral or useful; its large liver suggests that its food is more largely nectar than is indicated by the stomach contents.[21] Warren reported beetles and other insects and spiders in 62 stomachs.[22] One Nebraska stomach contained 4 small locusts.[23] A young bird was found to be filled with spiders.[24] Two nestlings only 24 hours out of the eggs contained insects.[25] In feeding experiments out-of-doors 1 bird took 2 teaspoonsful of sugar dissolved in water daily, the sugar weighing twice as much as the bird.[26] Observed feeding on sap at Sapsuckers' drill holes in birch trees.[27]

[20] Lucas, "The Food of Hummingbirds," *Auk*, X, 311-315, 1893.
[21] Beal and McAtee, *U. S. Dept. Agric., Farmers' Bull.* 506, 15-17, 1912.
[22] As cited by Sullivan, *Economic Value of Bird Life*, 32, 1912.
[23] Aughey, 1st Rept. *U. S. Entom. Com.*, 39, 1878.
[24] Eames, *Auk*, VII, 268-288, 1890.
[25] Brewster, *Auk*, IV, 255, 1887.
[26] Sherman, "Experiments in Feeding Hummingbirds During Seven Summers," *Wilson Bull.*, XXV, No. 85, 153-166, 1913; reprinted in *Ann. Rept. Smithsonian Inst. for* 1913, 459-468.
[27] Mitchell, *Condor*, XXI, 42, 1919.

Anna Hummingbird (*Calypte anna*); 111 stomachs; vegetable matter, only a trace of fruit pulp; Diptera (gnats and small flies, largely neutral), 45.23%; Hymenoptera, mostly useful, 35.03%; Hemiptera, 17.30%; spiders, 2%.[28] One contained 32 tree-hoppers, 1 spider, 1 fly and other insect remains.[29] Repeatedly observed catching flies on the wing.[30]

Fork-tailed Hummingbird or Porto Rican Emerald (*Chlorostilbon maugæi*); 35 stomachs, Porto Rico; food 100% animal matter, but 5% of total contents sand and earth; lantern flies (*Fulgoridæ*), 21.64%; undetermined Homoptera (mostly lantern flies), 12.76%; Diptera, 15.64%; Hymenoptera, 6.28%; spiders, 43.5%; unidentified, 0.18%; mostly injurious insects except the spiders.[31] Gilt-crested Hummingbird (*Microlyssa exilis exilis*); 7 stomachs, Porto Rico; food 100% animal matter; Homoptera, 14.29%, all injurious and all in 1 stomach; flies, 5%; Hymenoptera, including ants and parasitic species, 26.42%; spiders, 54.29%.[32] Porto Rican Mango (*Anthrocothorax aurulentus*); 30 stomachs, Porto Rico; vegetable matter (panic-grass seed in 1 stomach), 1.43%; lantern flies, 31.21%; other Homoptera, 20.14%; snout beetles, 3.26%; other Coleoptera, 5.97%, chiefly death watch and leaf beetles; Diptera, 16.93%; Hymenoptera, 29.81%; spiders, 7.80%; miscellaneous, 1.45%, chiefly earwigs.[33] Green Mango (*A. viridis*); 29 stomachs, Porto Rico; seeds, etc., 1.43%; small Homoptera, 20.66%, including identified Fulgoridæ, 6.35%; engraver beetles, 7.77%; other beetles, 2.07%; Diptera, 28.47%; ants, 6.77%; other Hymenoptera, 5.63%; spiders, 27.15%; 1 thrips, 0.05%.[34] Blue-breasted Hummingbird (*Sericotes holosericeus holosericeus*); 22 stomachs, Porto Rico; vegetable rubbish, 0.33%; Homoptera, 14.83%, largely lantern

[28] Beal and McAtee, *Farmers' Bull.* 506, 16-17, 1912.
[29] Clarke, *Condor*, V, 18, 1902.
[30] Bassett, *Condor*, XXII, 37, 1920. Mailliard, *Condor*, XXI, 212, 1919.
[31] Wetmore, *U. S. Dept. Agric., Bull.* 326, 71, 1916.
[32] Wetmore, *ibid.*, 70.
[33] Wetmore, *ibid.*, 73.
[34] Wetmore, *ibid.*, 73.

flies and a few leaf-hoppers; beetles, 0.83%; flies, 7.14%; minute Hymenoptera, 64.63%; spiders, 11.31%; unidentified, 1.07%.[35] *Helidoxa jacula henryi*, Costa Rica, seen eating berries of a small tree.[36]

[35] Wetmore, *ibid.*, 71.
[36] Smith, *Condor*, XXVIII, 243, 1926.

ORDER PASSERES. PERCHING BIRDS. (INCLUDES SONG BIRDS)

Family TYRANNIDÆ. *Tyrant Flycatchers*

These birds feed chiefly on flying insects captured on the wing, though the popular name for the family is a misnomer, inasmuch as true flies constitute only 13% of the total food of the 18 more important species and subspecies of the United States. Hymenoptera form the largest item in the food of 13 of them, hence that group, not the Diptera, may be considered the typical food of the family in the United States, at least. The table on opposite page, adapted with some modifications from Beal's great report on the food of Flycatchers,[1] based upon the examination of 3,398 stomachs of the 18 forms, shows the percentages (omitting fractions for the sake of brevity and "x" indicating less than 1%) of various kinds of food contained in the stomachs.

The table shown on page 222 has been compiled from Wetmore's report on Porto Rico birds.[2]

The table on page 223 is compiled from Aughey's report on the food of Nebraska birds.[3]

Insects constitute 96% of the food of the 16 species and subspecies of Flycatchers in California.[4] Though various species of this family are frequently accused of being enemies of the apiarist, 100 birds, mostly Arkansas Kingbirds, Say Phoebes and Black Phoebes, shot about California apiaries,

[1] Beal, "Food of Our More Important Flycatchers," *U. S. Biol. Surv., Bull.* 44, 1912. See also *Bull. 34 and Farmers' Bulls.* 506, 513, 630, etc.
[2] Wetmore, *U. S. Dept. Agric., Bull.* 326, 1916. See also Bowdish, *Auk*, XX, 193-195, 1903.
[3] Aughey, 1st Rept. *U. S. Entom. Com.*, 36-38, 1878.
[4] Beal, Yearbook *U. S. Dept. Agric. for* 1908, 343.

	Number of stomachs	Total animal food	Total vegetable food	Beetles	Wasps, bees and ants	Bugs	Flies	Grasshoppers and crickets	Moths and caterpillars	Miscellaneous insects	Spiders and Myriapods	Fruit	Miscellaneous vegetable food
		Food percentages, omitting fractions											
Scissor-tailed Flycatcher													
Muscivora forficata	129	96	3	13	12	10	3	46	4	x	4	..	1
Kingbird													
Tyrannus tyrannus	665	88	11	25	32	3	3	11	3	7	1	10	x
Arkansas Kingbird													
Tyrannus verticalis	109	90	9	17	31	5	x	27	7	x	x	9	x
Cassin Kingbird													
Tyrannus vociferus	40	78	21	14	21	3	2	14	18	2	x	19	2
Crested Flycatcher													
Myiarchus crinitus	265	93	6	16	13	14	3	15	21	4	4	5	x
Ash-throated Flycatcher													
Myiarchus cineracens cineracens	91	92	7	7	26	20	12	5	17	1	x	7	x
Phœbe													
Sayornis Phoebe	370	89	10	15	26	10	6	12	8	8	..	4	5
Say Phœbe													
Sayornis sayus	111	99	x	15	30	4	16	15	12	3	1	x	x
Black Phœbe													
Sayornis nigricans	344	99	x	13	30	10	28	2	8	5	x	x	x
Olive-sided Flycatcher													
Nuttallornis borealis	69	99	x	6	82	3	x	1	4	1	..	x	x
Wood Pewee													
Myiochanes virens	359	98	1	14	28	5	29	3	12	2	2	x	x
Western Wood Pewee													
Myiochanes richardsoni richardsoni	174	99	x	5	39	1	44	..	5	3	x	x	x
Yellow-bellied Flycatcher													
Empidonax flaviventris	103	97	2	16	46	4	14	..	5	x	8	2	x
Western Flycatcher													
Empidonax difficilis difficilis	157	99	x	8	38	8	31	x	6	x	4	x	x
Acadian Flycatcher													
Empidonax virescens	100	97	2	13	39	6	8	6	18	x	2	2	x
Traill and Alder Flycatchers													
Empidonax trailli trailli and E. t. alnorum	135	96	3	17	41	7	14	3	7	2	x	3	x
Least Flycatcher													
Empidonax minimus	177	97	2	21	41	11	11	2	7	x	2	1	x
Average	...	94	5	14	34	7	13	9	9	2	2	4	x

all contained drones, some being gorged with them, but no workers, hence the birds did little, if any, damage.[5]

Scissor-tailed Flycatcher (*Muscivora forficata*); 91 southern stomachs; 5 contained 7 cotton-boll weevils.[6]

Kingbird (*Tyrannus tyrannus*); though often called the "Bee-bird" or "Bee Martin," 665 stomachs contained only 61 honey bees altogether, 51 of which were drones, and the bees

[5] Beal, *U. S. Biol. Surv., Bull.* 34, 33, 1910; citing Bryant, *Zoe*, IV, 57-58.

[6] Howell, *U. S. Biol. Surv., Bull.* 29, 15, 1907; *Bull.* 25, 13, 1906. See also Bailey, *Bull.* 22, 1905.

Number of stomachs	10	61	29	4	89
	Antillean Elainea *Elainea m. martinica*	Porto Rican Petchary *Tolmarchus taylori*	Porto Rican Wood Pewee *Blacius blancoi*	Antillean Flycatcher *Myiarchus antillarum*	Gray Kingbird *Tyrannus dominicensis dominicensis*
	Food percentages				
Vegetable matter	85.50	23.91	0.83	15.83	22.40
Fruits, mostly wild	..	..	..	x	22.40
Seeds	..	21.13	0.83	..	..
Vegetable rubbish	..	1.96	..	..	..
Animal matter	14.50	76.09	99.17	84.17	77.60
Mole crickets	..	3.04	..	1.27	2.36
Other Orthoptera	..	2.68	0.56	3.97	0.95
Earwigs	..	..	..	..	4.72
Homoptera, largely cicadas	..	2.47	5.39	7.67	1.97
Heteroptera	..	0.88	1.45	..	..
Stinkbugs	..	..	..	2.33	2.12
Squashbugs	..	3.45	..	..	..
Other bugs	..	..	..	2.62	0.68
Cane-root weevils	..	18.47	..	11.22	17.19
Stalk-boring weevils	..	1.53	..	..	5.30
Miscellaneous weevils	..	2.40	..	8.09	1.34
Engraver beetles	..	..	8.86	..	..
Longicorn beetles	..	..	..	1.70	..
Leaf beetles	..	..	3.19	1.40	..
Ladybirds	..	1.53	3.87	..	..
Other Coleoptera	..	2.53	4.27	1.04	1.03
Honey bee workers	..	..	..	..	2.21
Bees, mostly wild	..	2.12	..	..	15.79
Other Hymenoptera, mostly wasps	..	6.10	23.07	10.51	11.23
Moths and caterpillars	..	4.17	10.87	25.85	4.75
Diptera	..	..	37.15	1.45	..
Snails	..	..	..	x	..
Miscellaneous invertebrates	..	4.73	0.49	x	2.42
Lizards	..	10.47	..	x	3.54
Tree toads	..	8.80	..	x	..

were confined to 22 stomachs; but on the other hand, 19 contained robberflies, which are enemies of the honey bee; total insect contents of all the stomachs, 10,000, including many harmful species and some useful ones.[7] Two California stomachs taken during a grasshopper outbreak contained 5 grasshoppers, 67.5% of the total contents.[8] Three from a canker-

[7] Beal, *U. S. Biol. Surv., Bull.* 44, 11-18; *Farmers' Bull.* 54, 12, 1898. See also Judd, *U. S. Biol. Surv., Bull.* 17, 36, 91-92, 1902. Barrows, *Ann. Rept. U. S. Dept. Agric. for* 1893, 233-234. Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 269, 1889. *Farmers' Bull.* 513, 23, 1913.

[8] Bryant, *Univ. Calif., Pub. Zool.*, XI, No. 1, 9, 1912.

	Number of stomachs	Average number of locusts	Average number of grasshoppers	Other insects	Seeds
Kingbird					
Tyrannus tyrannus	8	27	..	32	..
Crested Flycatcher					
Myiarchus crinitus	1	..	23	35	..
Phoebe					
Sayornis phoebe	9	23	..	21	few
Say Phoebe					
Sayornis sayus	1	32	..	..	..
Olive-sided Flycatcher					
Nuttallornis borealis	1	..	17	x	..
Wood Pewee					
Myiochanes virens	1	..	7	many	..
Western Wood Pewee	1	22			
M. richardsoni richardsoni	2	75%	..	..	..
Yellow-bellied Flycatcher					
Empidonax flaviventris	1	..	16	x	..
Least Flycatcher					
Empidonax minimus	4	10	..	15	..

infested orchard; cankerworms, over 25%; Hemiptera, 5%; balance Coleoptera.[9] Of 22 southern stomachs, September, 6 contained 8 cotton-boll weevils; of 10 April stomachs, 1 contained 1 cotton-boll weevil.[10]

Arkansas Kingbird (*T. verticalis*); 109 stomachs contained only 39 bees, confined to 5 stomachs, all drones but 2.[11] In Nebraska, seen catching locusts on the wing.[12] Cassin Kingbird (*T. vociferus*); food similar to that of Arkansas Kingbird.[13]

Crested Flycatcher (*Myiarchus crinitus*); 2 southern stomachs contained 5 cotton-boll weevils.[14] Ash-throated Flycatcher (*M. cineracens cineracens*); 91 stomachs; 5 from near an apiary contained no honey bees, but 1 contained 24 robberflies, an enemy of the honey bee.[15]

Phoebe (*Sayornis phoebe*); 370 stomachs; contained no

[9] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 15, 1903.
[10] Howell, *U. S. Biol. Surv., Bull.* 29, 15, 1907.
[11] Beal, *U. S. Biol. Surv., Bull.* 44, 19-22, 1912; *Bull.* 34, pp. 32-34, 1910; *Farmers' Bull.* 630, 24, 1915. Beal and McAtee, *Farmers' Bull.* 506, 18-19, 1912. *Farmers' Bull.* 513, 22, 1913.
[12] Aughey, 1st Rept. *U. S. Entom. Com.*, 37, 1878.
[13] See papers by Beal cited above.
[14] Howell, *U. S. Biol. Surv., Bull.* 29, 15, 1907.
[15] Beal, *U. S. Biol. Surv., Bull.* 44, 28-30; *Bull.* 34, 29-30, 1910. Beal and McAtee, *Farmers' Bull.* 506, 19-21, 1912.

honey bees, but there are reports of its feeding upon them.[16] One of the most useful birds about the farm.[17] Of 13 stomachs from the South, 4 or more contained 1 cotton-boll weevil each.[18] Say Phoebe (*S. sayus*); 111 stomachs; none contained honey bees.[19] Nebraska stomachs crowded with insects.[20] Black Phoebe (*S. nigricans*); 344 stomachs; no honey bees found in them.[21] One California stomach; 3 grasshoppers, 50% of total contents.[22]

Olive-sided Flycatcher (*Nuttallornis borealis*); 69 stomachs; 63 honey bees (36 workers, 27 drones); confined to 16 stomachs, 25 of them in 1.[23] One southern stomach contained 2 cotton-boll weevils.[24] Wood Pewee (*Myiochanes virens*); 359 stomachs contained only 2 honey bees.[25] Takes large numbers of harmful insects and many useful parasitic wasps.[26] Three from a canker-infested orchard; no cankerworms taken; flies and gnats, 13%; scarabid beetles, 13%; clavicorn beetles, 10%; a few ants, etc.[27] Western Wood Pewee (*M. richardsoni richardsoni*); 174 stomachs; no honey bees found; probably takes 2,400 insects each 10-hour day.[28]

Yellow-bellied Flycatcher (*Empidonax flaviventris*); 1 stomach from a canker-infested orchard; several caterpillars but no cankerworms; Coleoptera, about 50%.[29] Western Flycatcher (*E. difficilis difficilis*); 141 stomachs, California; no honey bees found.[30] One from New Mexico contained beetles.[31] Traill Flycatcher (*E. trailli trailli*); 2 stomachs

[16] Beal, *Bull.* 44, 30-35.
[17] Beal, *Farmers' Bull.* 630, 21-22, 1915.
[18] Howell, *U. S. Biol. Surv., Bull.* 25, 13, 1906; *Bull.* 29, 15, 1907. Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905.
[19] Beal, *Bull.* 44, 36-38; *Bull.* 34, 35-36; *Farmers' Bull.* 54, 13; *Farmers' Bull.* 630, 23.
[20] Aughey, 1st Rept. *U. S. Entom. Com.*, 37, 1878.
[21] Beal, *Bull.* 44, 38-41; *Bull.* 34, 36-39; *Farmers' Bull.* 630, 22-23.
[22] Bryant, *Univ. Calif. Pub. Zool.*, XI, No. 1, 9, 1912.
[23] Beal, *Bull.* 44, 41-44.
[24] Howell, *U. S. Biol. Surv., Bull.* 29, 15.
[25] Beal, *Bull.* 44, 44-49.
[26] Judd, *U. S. Biol. Surv., Bull.* 17, 92-93, 1902.
[27] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 15, 1903.
[28] Beal, *Bull.* 44, 49-51; *Bull.* 34, 39-41.
[29] Forbes, *supra*, 15.
[30] Beal, *U. S. Biol. Surv., Bull.* 34, 41-44.
[31] Cockerell, *N. Mex. Exper. Sta., Bull.* 37, 38, 1901.

from a canker-infested orchard; contents ¼ cankerworms, ⅓ Ichneumonidæ, ¼ Coleoptera, $\frac{1}{10}$ ants and other Hymenoptera.[32] Alder Flycatcher (*E. t. alnorum*); of 3 southern stomachs, 1 contained 2 cotton-boll weevils.[33] Least Flycatcher (*E. minimus*); of 15 southern stomachs, 7 contained 21 cotton-boll weevils.[34]

Family Alaudidæ. *Larks*

Skylark (*Alauda arvensis*); long recognized as a beneficial insectivorous bird and protected from May to September in parts of Europe,[35] but is said to have developed injurious habits upon introduction to a different environment in New Zealand.[36]

Horned Larks (*Otocoris alpestris*, various subspecies); feed in winter almost entirely on seeds, largely weed seeds, with some waste grain.[37] Except in Southern California, vegetable matter constitutes 79.4% (weed seeds, 63.9%) and animal matter 20.6% of the entire food.[38] Of 1,154 stomachs, 22 contained no vegetable matter; 634 contained nothing else; 1,070 contained weed seeds and 206 contained nothing else; grass and sedge seeds, 26.21%; fruit, 0.25%; grain, 40.2% in California, 12.2% elsewhere, chiefly waste grain, but includes considerable freshly-sown seed grain; animal matter, 20.6%; beneficial insects, only 0.25%; weevils, 4.5% for the year, 18% in August; grasshoppers, 2.5% for the year, 8.9% in August; May to August inclusive, ½ of food insects.[39] In 259 California stomachs, vegetable matter, 91%; animal matter,

[32] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 15.
[33] Howell, *U. S. Biol. Surv., Bull.* 29, 15.
[34] Howell, *Biol. Surv., Bull.* 29, 14; *Bull.* 25, 13.
[35] McAtee, "The Horned Larks and their Relation to Agriculture," *U. S. Biol. Surv., Bull.* 23, 11, 1905.
[36] Palmer, "The Danger of Introducing Noxious Animals and Birds," *Yearbook U. S. Dept. Agric. for* 1898, 106.
[37] Judd, *U. S. Biol. Surv., Bull.* 17, 93, 1902; Yearbook *U. S. Dept. Agric. for* 1898, 230. *Farmers' Bull.* 513, 22, 1913. Barrows, *Michigan Bird Life*, 409, 1912.
[38] Beal and McAtee, *Farmers' Bull.* 506, 23-25, 1912.
[39] McAtee, *U. S. Biol. Surv., Bull.* 23, 1905. Barrows, "The Food of Horned Larks or Shore Larks," Yearbook, *U. S. Dept. Agric. for* 1892, 193-197.

9%; wheat, 9%; oats, 31%; both largely waste from stubble; weed and grass seeds, 51%; beetles, 5%, mostly harmful, including weevils; miscellaneous insects, 4%.[40] During a grasshopper outbreak in California, 2 stomachs contained 5 grasshoppers, 7.5% of the total contents; animal matter, 52.5%; vegetable matter, 47.5%.[41] One Nebraska stomach, June 16; 42 locusts, 33 small seeds.[42] Six stomachs obtained in Utah in May, during an outbreak of alfalfa weevils; alfalfa weevils, 41%; caterpillars, over 17%; ground beetles, 6%; grasshoppers, 5%; vegetable matter, 26.5%, ⅓ weed seeds, ⅔ wheat; 5 June stomachs; weevils, 29%.[43] These birds doubtless do considerable good in the suppression of insects and the reduction of the annual crop of weeds, much more than balancing the small amount of harm they do in taking grain from newly-sown fields, though capable of considerable harm when they occur in large numbers at sowing time.

Family Corvidæ. *Crows, Jays, Magpies, etc.*

Several members of this family are, at least in some localities, more harmful than useful, though all have some good qualities. "Among the most formidable bird enemies of field mice are the larger members of the Crow family (Corvidæ). The fact that Ravens, Hooded Crows and Rooks feed upon voles and lemmings has often been noted." American Ravens and Crows take field mice "whenever occasion offers." Depredations by small rodents have often followed the destruction of Crows by means of bounties.[44] In addition to the considerable percentage of insects in the food of adult Crows, their nestlings, as well, probably, as those of the other members of the family, are at first fed chiefly on insects.[45]

[40] Beal, *U. S. Biol. Surv., Bull.* 34, 44-47, 1910.
[41] Bryant, *Univ. Calif. Pub. Zool.*, XI, No. 1, 9, 1912.
[42] Aughey, 1st Rept. *U. S. Entom. Com.*, 18-19, 1878.
[43] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 10-11, 1914.
[44] Lantz, "An Economic Study of Field Mice," *U. S. Biol. Surv., Bull.* 31, 50-51, 1907.
[45] Judd, "The Food of Nestling Birds," Yearbook *U. S. Dept. Agric. for* 1900, 424-426.

Magpie (*Pica pica hudsonia*); bad habits probably outweigh the good done in the destruction of noxious mammals, insects, etc., especially where the birds are abundant. They "destroy mice to some extent."[46] One Nebraska stomach full of insects; destroys eggs and young birds,[47] including many eggs of Wild Ducks.[48] One is reported to have killed a rattlesnake after a long struggle.[49] Omnivorous, fond of cherries and even feeds upon carrion or any other offal.[50] In Utah, during an alfalfa weevil outbreak, 134 nestling stomachs taken in May; weevils, 2.42% (found in 79 birds); caterpillars, 22.1%; muscid larvæ and pupæ, 16.34%; ground beetles, 5.15%; other beetles, 4.05%; also bird remains and seeds; June nestlings, weevil percentage much higher; 5 adult stomachs, May; weevils, 26%; carrion, 40%; June adults; weevils, 9.67%.[51]

Locally Magpies have been known in several states to do some damage to sheep, hogs and cattle, by pecking holes in their backs, sometimes digging to the kidneys or exposing the entrails, causing festering sores and even resulting in the death of the animals. This habit is also attributed to the African Ox-pecker (*Buphaga africana*).[52]

Blue Jay (*Cyanocitta cristata cristata*); nest-robbing frequently reported, but perhaps less common than generally supposed; 292 stomachs; only 3 contained egg shells of wild birds and 2 contained remains of wild birds; 11 contained egg shells of domestic fowl; mineral matter, 14%; of the food, 75.7% was vegetable matter, 24.3% animal matter; insects 23% (19% noxious species) for the year, 1% in February, 66% in August; grasshoppers, crickets and locusts, 4.4%;

[46] Lantz, *U. S. Biol. Surv., Bull.* 31, 50, 1907.
[47] Aughey, 1st Rept. *U. S. Entom. Com.*, 36, 1878.
[48] Wetmore, U. S. Dept. Agric., *Dept. Bull.* 936, 16-17, 1921.
[49] Boulder, Colorado, *Daily Camera*, June 4, 1925; citing Longmont, Colorado, *Times*.
[50] Dice, *Condor*, XIX, 123, 1917.
[51] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 11-14, 1913.
[52] Berry, *Condor*, XXIV, 13-17, 1922. *Auk*, XXX, 129, 1913; citing *U. S. Bureau Entom., Bull.* 106, 1912. Schorger, *Auk*, XXXVIII, 276-277, 1921. Stephens, *Auk*, XXXVIII, 458-459, 1921.

corn, 17.9%; mast, 42%; "does far more harm than good."[53] One Nebraska stomach; 45 locusts and some seeds.[54] Seen eating cankerworms on trees in a canker-infested orchard.[55] Estimated that a pair feed their young 500,000 caterpillars in a season, and destroy 1,000,000 insect eggs in winter.[56]

Steller and Coast Jays (*C. stelleri stelleri* and *C. s. carbonacea*); 93 stomachs, California; vegetable matter, 72%; animal matter, 28%; beetles, 8%, mostly noxious species, including weevils; Hymenoptera, 11%, none parasitic and only 3 honey bees; Hemiptera, 1%; Diptera, 4%; grasshoppers and crickets, 3.5%; fruit, 22%; grain, 5%; mast, 42.5%; seeds, galls, etc., 2.5%.[57] Long-crested Jay (*C. s. diademata*); they "search the branches and bark for codling moth cocoons and are death on grubs."[58] One Utah stomach; 1 weevil, 1 dung beetle, 1 bee, 1 caterpillar, carrion, grain and a mass of dandelion seeds.[59] Has a better reputation than the Blue Jay.

Florida Jay (*Aphelocoma cyanea*); stomachs contained Lepidoptera and Coleoptera.[60] Woodhouse Jay (*A. woodhousei*); 3 Utah stomachs contained chiefly ground beetles, mast and wheat; egg shell in 1; habits better than those of the next species.[61] In Oklahoma it feeds upon grasshoppers, pine nuts and acorns.[62] California Jay (*A. californica*); record bad; robs many bird nests, kills chicks and has acquired an appetite for cultivated fruit and nuts; 326 stomachs; vegetable matter, 73%; animal matter, 27%; predaceous beetles, 2.5%; harmful and neutral beetles, 8%; Hymenoptera, 5%; 20 honey bees in 9 stomachs, all workers; Hemiptera, 0.5%; moths and caterpillars, 2.5%, including codling moths;

[53] Beal, "The Blue Jay and its Food," Yearbook *U. S. Dept. Agric. for* 1896, 197-206; *Farmers' Bull.* 630, 19-20, 1914. *Farmers' Bull.* 513, 21, 1914. Judd, *U. S. Biol. Surv., Bull.* 17, 93-94, 1902.
[54] Aughey, 1st Rept. *U. S. Entom Com.*, 36, 1878.
[55] Forbes, *Bull. Ill. Lab. Nat. Hist.*, I, No. 6, 17, 1903.
[56] Richards, *Pop. Sci. Monthly*, July, 1896, 337; citing Brewer.
[57] Beal, *U. S. Biol. Surv., Bull.* 34, 47-49, 1910.
[58] Cockerell, *N. Mex. Exper. Sta., Bull.* 37, 40, 1901.
[59] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 14, 1914.
[60] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 269, 1889.
[61] Kalmbach, *supra, Bull.* 107, 14-15.
[62] Tate, *Bull. Univ. Oklahoma*, N. Ser., No. 322, 34, 1925.

grasshoppers and crickets, 4.5%; spiders, snails, etc., 1%; grain, 11.73%; fruit, 22.5%; mast, 38.22%; also egg shells, bird feathers and remains of lizards, snakes and mammals.[63]

Canada Jay and Rocky Mountain Jay (*Perisoreus canadensis canadensis, P. c. capitalis*); will eat almost anything that is eatable and take any kind of food lying about camp, hence called Camp Robbers; great scavengers.[64]

Raven and Northern Raven (*Corvus corax sinuatus, C. c. principalis*); omnivorous and to some extent scavengers, feeding on dead fish and other carrion; along seacoast eat mollusks; 1 Nebraska stomach contained 12 locusts, with other insects.[65]

Crow (*C. brachyrhynchos,* various subspecies); omnivorous; economic status has been much investigated and discussed; 909 stomachs; animal matter, 32.9%; vegetable matter, 56.8%; mineral matter, 10.3%; rabbits, 5%; mice, 1.1%; carrion, 3%; wild birds and their eggs, 6%; poultry and eggs, 4%; tortoises, 2%; snakes, 4%; amphibians, 1.2%; fish, 4%; crustaceans, 9%; mollusks, 3%; insects, 23.5% for the year, ranging from 10% in February to 67% in May.[66] In 1,103 stomachs, highly injurious insects constituted 80% of the insect food (grasshoppers, May beetles, caterpillars, weevils, wireworms, etc.); 50 contained remains of wild birds; does considerable good and some harm.[67] Its reduction in numbers where abundant and seriously harmful is justifiable.[68] Takes mice at every opportunity, but its protection not considered

[63] Beal, *U. S. Biol. Surv., Bull.* 34, 50-56, 1910; Yearbook *U. S. Dept. Agric. for* 1904, 248-250. *Farmers' Bull.* 513, 21, 1913.

[64] Bendire, "Life Histories of North American Birds," *Special Bull.* 3, 386-387, 1895. Skinner, *Condor,* XXIII, 147, 1921.

[65] Barrows, *Michigan Bird Life,* 417, 1912. Willett, *Lorquinia,* II, 33, 1917. Aughey, 1st Rept. *U. S. Entom. Com.,* 35, 1878.

[66] Barrows and Schwarz, "The Common Crow of the United States," U. S. Dept. Agric., Div. Orn. and Mam., *Bull.* 6, 110 pages, 1895. Barrows, Ann. Rept. *U. S. Dept. Agric. for* 1888, 498-535. *Nat. Geog. Mag.,* XXXVII, 322-338, 1920. See also: Gardner, "Experiments in the Economic Control of the Western Crow (*Corvus brachyrhynchos hesperis*)," *Auk,* XLIII, 447-461, 1926. Kalmbach, "The Crow in Its Relation to Agriculture," U. S. Dept. Agric., *Dept. Bull.* No. 1102, 1920.

[67] Beal, U. S. Dept. Agric., *Farmers' Bull.* 630, 17-19, 1915.

[68] *Farmers' Bull.* 513, 20, 1913.

desirable locally by Judd.[69] A growing menace to bird life in portions of the West, because of increasing numbers.[70] All Nebraska stomachs contained locusts or other insects.[71] The Crow does great damage to pecans in Oklahoma, and is estimated to have done $1,200,000 to $1,424,000 damage to other crops in that state in 1918, mostly to grain.[72] Crows have been caught killing full-grown Quail.[73] Along seacoasts they eat mollusks.[74] They, with other birds, have been frequently accused of carrying epidemic diseases of live stock, a matter more fully discussed in a preceding chapter, on Birds as Disease Carriers.

The most thorough analysis of the food of Crows is that of Kalmbach, based upon an examination of 2,118 stomachs (1,340 adults, 778 nestlings), from 39 states, the District of Columbia and several Canadian provinces, and representing every month of the year. He concludes that it does a large amount of good in the destruction of noxious animals, etc., but where it occurs in over-abundance it does a great deal of harm; that its extermination would be as serious as its over-abundance, but its numbers should be kept within reasonable bounds.[74a]

Florida Crow (*C. b. pascuus*); stomachs contained frogs and insects.[75] Porto Rican Crow (*C. leucognaphalus leucognaphalus*); 9 stomachs, Porto Rico; animal matter, 10.56%, composed of bird fragments in 1, tree toad in another; vegetable matter, 89.44%, largely wild fruits of no economic importance.[76]

Clarke Nutcracker (*Nucifraga columbiana*); in winter its food is largely conifer seeds, hence its popular name; in sum-

[69] Judd, *U. S. Biol. Surv., Bull.* 17, 53-54, 94, 1902.
[70] Brooks, *Condor*, XXVII, 83-84, 1925.
[71] Aughey, 1st Rept. *U. S. Entom. Com.*, 36, 1878.
[72] Hoffman, *Wilson Bull.*, XXXVI, 175-184, 1924; citing Okla. Agric. Exper. Sta., *Bull.* 128, 1919.
[73] Childs, *Auk*, XXXIII, 435, 1916.
[74] Willett, *Lorquinia*, II, 33, 1917.
[74a] Kalmbach, *U. S. Dept. Agric., Bull.* 621, 90 pages, 1918.
[75] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 269, 1889.
[76] Wetmore, *U. S. Dept. Agric., Bull.* 326, 94, 1916.

mer it takes a great variety of food, including various kinds of berries and especially many kinds of insects.[77] One Nebraska stomach contained 42 locusts, with seeds.[78]

Family Sturnidæ. *Starlings*

The European Starling (*Sturnus vulgaris*) has been introduced into the United States and has already spread over a large territory east of the Mississippi River, northward into Canada, and has even appeared in British Columbia and Oregon.[79] It was considered a useful bird in England until it became over-abundant, but has now become a "serious menace to the production of home-grown food." Its food consisted largely of insects, slugs, snails, weed seeds and wild fruits, but is now supplemented by a considerable proportion of cereals and cultivated fruits. The relative percentages of certain foods of this bird in Europe and the United States, as shown by stomach examinations, are as follows: [80]

	Number of stomachs	Cereals	Injurious insects	Wild fruits and weed seeds
British	368	20.50%	26.50%	7.00%
American	2,157	1.16%	34.66%	23.86%

It is thus seen that it is at present a much less harmful and more useful bird in America than in Great Britain, but it is rapidly increasing in numbers in America and is already doing

[77] Bendire, "Life Histories of North American Birds," U. S. Natl. Museum, *Special Bull.* 3, 419-420, 1895. Judd, Yearbook *U. S. Dept. Agric. for* 1900, 426.

[78] Aughey, 1st Rept. *U. S. Entom. Com.*, 36, 1878.

[79] *Auk*, XL, 536-539, 1923; XLII, 272-274, 1925. *Bird-Lore*, IX, 171, 206, 1907; XXIV, 212, 1924. *Condor*, XXVI, 125, 1924. U. S. Dept. Agric., *Circular No.* 336, 1925. Bull. *Cleveland Mus. Nat. Hist.*, No. 2, 6, 1922.

[80] Kalmbach, "A Comparison of the Food Habits of British and American Starlings," *Auk*, XXXIX, 189-195, 1922; citing Collinge, *The Food of Some Wild British Birds*, 49, 1913; "The Plague of Starlings," *Natl. Review*, No. 434, 252-253, 1919; "The Starling: Is it Injurious to Agriculture?" *Journ. Ministry Agric.*, XXVII, 1114-1121, 1921. *Science Gossip*, Dec., 1885, 281.

considerable damage locally, especially to fruit. It is capable of much good, but potentially harmful because of its gregarious habits and its propensity to increase under favorable conditions. It is reported to have become destructive in Australia and Tasmania, where it has been introduced.[81]

In United States, 2,157 stomachs of adults; vegetable matter, 43% for the year, 52.67% in July (mulberries and cherries, 50.74%); animal matter, 57% for the year; insects, 41.55%; Coleoptera, 19.59% (weevils, 8.5; nearly ½ contained cloverleaf weevils; ground beetles, 5.71; lamellicorn beetles, 2.24); Orthoptera, 12.41%, chiefly short-horned grasshoppers and crickets; Lepidoptera, 6.04%, mainly caterpillars; Hymenoptera, 1.75%; Diptera, 0.5%; millipeds, 11.71%; spiders, 1.48%; mollusks, 0.94%; crustaceans, salamanders, garbage, etc., 1.32%; cherries, 2.66% for the year, 17.01% in June, 14.92% in July (compare Robin, 8.63% for the year); other cultivated fruit, 1.75%, chiefly apples; corn, 0.77%; small grain, 0.39%; wild fruit, 23.86%; miscellaneous vegetable matter, 13.57%; 325 nestling stomachs, May and June; animal matter, 95.06%; caterpillars, etc., 38.21%, largely cutworms; beetles, 29.98%, nearly ½ Scarabæidæ, including white grubs; weevils, 3.26%; Orthoptera, 11.31%, mostly crickets; spiders, 8.56%; millipeds, 4.56%; cherries, 3.18%.[82] In Massachusetts, 102 stomachs; over ½ had eaten caterpillars, 40% of contents; 18 averaged 56.17% cherries.[83] In New Jersey destructive to cherries and peas.[84] It is a pugnacious bird, driving away other hole-nesting birds.[85]

Crested Mynah (*Aethiopsar cristatellus*); introduced to British Columbia and Oregon; scavenger, taking all sorts of refuse food; fond of fruit, especially cherries; 8 stomachs; contents almost entirely vegetable matter.[86] Common Mynah

[81] Palmer, Yearbook *U. S. Dept. Agric. for* 1898, 101-103.
[82] Kalmbach and Gabrielson, "Economic Value of the Starling in the United States," *U. S. Dept. Agric., Bull.* 868, 1921. *Auk*, XXXVIII, 294-295, 1921.
[83] Wood, "The Starling Family at Home and Abroad," *Condor*, XXVI, 123-136, 1924.
[84] Kohler, *Oologist*, XXXVII, 47, 1920.
[85] Wood, *ibid.*, 125. Cooke, U. S. Dept. Agric., *Circular* No. 336, 1925.
[86] Wood, *Condor*, XXVI, 132-136, 1924.

(*A. tristis*); introduced into Hawaiian Islands, Philippines and other Pacific Islands and other countries; habits much as those of other members of the family.[87]

Family ICTERIDÆ. *Bobolinks, Blackbirds, Meadowlarks, Orioles, etc.*

The following table is compiled from Aughey's report on the food of Nebraska birds, with special reference to locusts: [88]

	Number of stomachs	Grasshoppers	Average number of locusts	Seen eating locusts	Average number of beetles	Average number of other insects	Average number of seeds
Bobolink, Dolichonyx oryzivorus	6	..	7	..	..	9	many
Cowbird, Molothrus ater ater	..	..	..	x	..	..	..
Yellow-headed Blackbird, Xanthocephalus xanthocephalus xanthocephalus	20	..	7	..	..	37	19
Red-winged Blackbird, Agelaius phœniceus phœniceus	1	..	full	x	..	..	..
Meadowlark, Sturnella neglecta?	9	..	23	..	..	8	many
Orchard Oriole, Icterus spurius	2	¾ full	..	..	..	..	..
Baltimore Oriole, Icterus galbula	..	..	..	x	..	..	..
Bullock Oriole, Icterus bullocki	1	..	35	..	3	..	x
Rusty Blackbird, Euphagus carolinus	x	..	⅘ full	..	..	x	x
Brewer Blackbird, Euphagus cyanocephalus 5 contained corn	12	..	¾ full	..	..	..	..
Purple Grackle, Quiscalus quiscula quiscula	x	..	full	..	..	..	..

The table on the following page has been compiled from Beal's Bulletin on the food of Bobolinks, Blackbirds and Grackles.[89]

[87] Wood, *ibid.*, 127-132.
[88] Aughey, 1st Rept. *U. S. Entom. Com.*, 1878.
[89] Beal, Food of Bobolinks, Blackbirds and Grackles, U. S. Biol. Surv., Bull. 13, 1900.

	Time of year	Number of stomachs	Food percentages: Total animal matter	Lepidoptera, mostly caterpillars	Beetles and weevils	Grasshoppers	Leaf hoppers	Miscellaneous insects	Miscellaneous animal matter	Total vegetable matter	Weed seeds	Grain	Fruit
Bobolink. Dolichonyx oryzivorus from northern breeding grounds. In June, injurious insects, 90%; September, 5%	....	291	57.7	..	..	..	..	..	..	429	..	..	..
Cowbird. Molothrus ater ater	....	544	23.30	..	5.30	11.00	..	..	..	77.70	..	16.50	x
	June	..	58.00	..	..	..	..	..	..	..	..	..	..
	Jan.	..	2.00	..	..	..	..	..	..	..	..	..	..
	Dec.	..	2.00	..	..	..	..	..	..	..	..	..	..
Some stomachs	....	..	..	..	..	..	60	..	..	..	..	..	..
Yellow-headed Blackbird Xanthocephalus x. xanthocephalus	....	138	33.70	4.60	7.80	11.60	..	x	x	66.30	..	38.90	28.00
	July	..	..	21.50	..	..	..	..	..	..	..	..	6.60
	Sept.	..	..	..	..	..	..	..	..	..	..	..	64.60
Redwings. Agelaius phoeniceus, various subspecies	....	1083	26.60	5.90	10.00	..	..	x	x	73.40	..	13.9	54.60
	Jan.	..	1.40	..	..	..	..	..	..	98.60	..	..	..
	May	..	..	20.00	..	4.70	..	..	..	..	..	..	..
	June	..	88.10	..	22.40	17.00	..	..	..	..	..	..	..
	Aug.	..	..	..	..	..	..	..	..	..	..	..	..
Purple Grackle	....	25.00	..	..	..	..	..	27.00	..	..	..	56.00	..
Quiscalus quiscula quiscula	Feb.	..	..	..	..	..	..	3.00	..	..	7.00	..	7.0
1,059 contained weevils	May	..	..	..	..	..	..	72.00	..	..	..	..	13.00
1 contained 13 crayfish	June	..	..	..	..	..	..	..	..	..	..	..	10.00
	July	..	..	..	..	23.40	..	..	..	..	..	..	..
	Aug.	..	..	..	..	..	..	..	..	..	11.00	..	..
	Oct.	..	..	..	..	..	..	..	..	..	..	..	..
Nestlings	....	..	74.00	..	..	..	..	70.00	..	..	..	..	..
Boat-tailed Grackle	....	132	..	..	..	7.30	..	..	25.30	..	..	46.80	x
Megaquiscalus major major	July	..	..	..	..	31.90	..	..	..	..	..	..	..
	Aug.	..	..	..	..	47.70	..	..	..	..	..	..	..
Rusty Blackbird	....	132	..	..	13.80	12.00	..	..	..	..	..	24.40	6.00
Euphagus carolinus	Aug.	..	..	..	..	44.30	..	..	..	..	..	..	..
Spiders and myriapods, 11%	....	..	..	..	..	..	..	..	..	..	..	..	..

	Time of year	Number of stomachs	Food percentages													
			Total animal matter	Alfalfa weevils	Miscellaneous Coleoptera, mostly injurious	Lepidoptera, mostly caterpillars	Grasshoppers and crickets	Hymenoptera	Hemiptera	Diptera	Dragonflies	Spiders	Snails	Total Vegetable matter	Grain	Weed seeds
Bobolink. Dolichonyx oryzivorus																
Beneficial character in West and North undisputed	June	7	..	63.00	..	16.00	..	..	8.00	..	..	..	..	..	..	..
Cowbird. Molothrus ater ater	Year	..	..	..	..	..	..	..	18.70	..	..	..	..	27.00	..	18.30
	May	3	..	60.00	..	..	..	..	..	..	..	..	..	..	..	..
	June	10	..	42.30	..	..	..	..	..	..	..	..	..	..	..	..
	July	2	..	30.00	..	..	..	..	..	..	..	..	..	..	..	..
Yellow-headed Blackbird. Xanthocephalus x. xanthocephalus	April	1	..	..	..	97.00	..	..	..	..	..	..	..	..	..	..
	May	1	..	10.00	..	..	..	..	..	..	..	..	..	..	..	..
	June	21	..	47.72	8.56	31.00	..	..	4.95	..	2.48	..	..	1.20	..	..
	July	7	..	..	..	..	..	..	..	..	..	..	..	..	44.57	..
	June	68	..	4.27	5.70	24.08	4.00	2.10	..	..	43.86	5.54	3.76	2.13	..	..
Thick-billed Redwing Agelaius p. fortis.	Nestlings	50	..	10.64	10.00	27.38	..	..	..	..	9.84	15.00	6.46	6.84	..	..
	Adults	120	..	16.51	6.85	9.87	..	..	..	9.09	..	1.00	..	38.21	20.00	..
Western Meadowlark Sturnella neglecta	April	..	..	50.00	12.50	22.00	..	6.50	..	..	..	..	..	..	15.89	12.00
	May	..	..	..	25.00	31.66	6.33	..	..	..	..	..	..	9.00	6.00	..
	June	..	..	12.50	24.00	50.00	..	6.50	..	..	..	4.70	..	x	..	..
Bullock Oriole. Icterus bullocki	May	..	..	..	..	33.00	..	..	..	..	..	..	..	..	..	..
	June	..	..	8.00	..	33.00	..	..	..	..	..	..	..	20.00	..	..
	July	..	..	16.00	..	..	..	..	..	..	..	..	..	..	..	..
Brewer Blackbird Euphagus cyanocephalus	Nestlings	78	94.00	20.14	11.45	34.57	..	..	..	..	..	9.37	..	6.08	..	..
	Young	45	..	25.47	8.67	13.18	38.50	11.29	10.11	..	..	..	..	22.2	14.00	..
	Adults	45	..	13.00	..	..	..	..	..	..	..	..	..	..	43.00	..
	"	99	..	16.85	6.50	15.67	..	..	6.50	..	..	..	..	34.11	..	..
	"	..	..	32.07	..	27.83	..	..	..	..	..	..	..	5.00	..	..
	July	..	..	20.27	..	..	27.20	..	..	..	..	..	..	11.52	..	..

The table on page 235 has been compiled from Kalmbach's bulletin on birds in relation to an outbreak of alfalfa weevils.[90]

The following table has been compiled from various publications by Bryant: [91]

	Number of stomachs	Animal matter	Grasshoppers	Cutworms	Other caterpillars	Beetles	Vegetable matter	Grain	Weed seeds
	Food percentages								
Yellow-headed Blackbird from tule swamp Xanthocephalus x. xanthocephalus .	1	15.00	None	..	..	..	85.00	..	..
Bicolored Redwing Agelaius gubernator californicus . .	10	88.50	54.68	..	..	..	10.50	..	..
Tricolored Redwing. Agelaius tricolor .	1	97.00	97.00	..	..	..	3.00	..	..
Western Meadowlark. Sturnella neglecta	1200	59.00	15.00	5.00	5.00	17.00	..	..	40.00
From Red Bluffs, Feb. to June	54	..	..	31.00	..	..	..	..	..
From El Toro	..	..	73.23	..	..	..	..	..	..
Jan. to Dec.	..	64.60	26.40	18.30	..	35.40	35.40	22.20	..
During grasshopper outbreak .	10	99.00	83.10	..	..	..	..	..	..
1 stomach, 4 plant lice, 9 beetles, 12 crickets	..	..	..	..	..	..	..	..	..
Bullock Oriole. Icterus bullocki . . .	10	98.00	92.00	..	..	..	2.00	..	..
Brewer Blackbird. Euphagus cyanocephalus	1	95.00	80.00	..	..	..	5.00	..	..

The table opposite has been compiled from Beal's report on birds in relation to the fruit industry of California.[92]

Where rice fields lie along the main migration routes of the Bobolink (*Dolichonyx oryzivorus*), great flocks of them, some-

[90] Kalmbach, "Birds in Relation to the Alfalfa Weevil," *U. S. Dept. Agric., Bull.* 107, 1914.

[91] Bryant, "Birds in Relation to a Grasshopper Outbreak in California," *Univ. Calif. Pub. Zool.*, XI, 1-20, 1912; "A Determination of the Economic Status of the Western Meadowlark (*Sturnella neglecta*) in California," *ibid.*, 377-510, 1914 (not examined); "Economic Value of the Western Meadowlark in California," *Univ. Calif., Agric. Exper. Sta., Bull.* 236, 1913; "The Number of Insects Destroyed by Western Meadowlarks (*Sturnella neglecta*) in California," *Science*, XXXVI, n. ser., pp. 873-875, 1912; "Results of Some Miscellaneous Stomach Examinations," *Condor*, XV, 92-93, 1913.

[92] Beal, "Birds of California in Relation to the Fruit Industry," *U. S. Biol. Surv., Bull.* 34, 1910. Compare also Beal, *Farmers' Bull.* 630, 1915. *Farmers' Bull.* 513, 1913.

Number of stomachs	312	162	91	16	198	12
	Brewer Blackbird Euphagus cyanocephalus	Bullock Oriole Icterus bullocki	Western Meadowlark Sturnella neglecta	Tricolored Redwing Agelaius tricolor	Bicolored Redwing Agelaius gubernator californicus	Redwing Agelaius phœniceus, subspecies
Vegetable matter	68.00	21.00	30.00	21.00	86.00	37.00
Grain	54.00	..	27.50	x	70.00	..
Weed seeds	9.00	..	2.00	x	15.00	x
Fruit	4.00	9.00	..	..	..	..
Animal matter	32.00	79.00	70.00	79.00	14.00	63.00
Beetles	11.00	35.00	27.00	x	5.00	20.00
Grasshoppers and crickets	3.50	..	12.00	..	1.50	20.00
Lepidoptera, mostly caterpillars	12.00	41.00	15.00	x	5.50	20.00
Hymenoptera, mostly wasps and ants	1.70	15.00	6.00	..	1.00	..
Hemiptera	1.00	10.00	4.00	..	1.00	..
Diptera	1.50	..	x	..	..	3.00
Miscellaneous insects	..	x	..	..	..	..
Spiders	..	x	x	..	..	..
Sowbugs	..	..	x	..	..	..
Snails	..	..	x	..	..	..
Egg shell	..	x	..	..	..	..
Lizard	..	x	..	..	..	..

times from 25,000 to 30,000 in a 60-acre field,[93] do much damage, feeding upon sprouting rice in the spring and ripening rice in the autumn,[94] damaging the crop in the Carolinas to the extent of 10%.[95] In 1900 it was estimated that the Bobolink's damage to rice fields in the South was $2,000,000,[96] but rice-growing has shifted westward, so that now the fields are to a considerable extent outside the main migration routes.[97] During the nesting season the food is largely insects; afterwards, mostly weed seeds.[98]

Cowbird (*Molothrus ater ater*); one Illinois stomach, May; corn, 60%; some seeds of *Polygonum*, etc.; some Coleoptera.[99] In the South, of 31 stomachs, 4 contained 4 cotton-boll weevils;

[93] McAtee, *Auk*, XXXVI, 430-431, 1919.
[94] Beal, U. S. Dept. Agric., *Farmers' Bull.* 630, 17, 1915.
[95] *Farmers' Bull.* 513, 20, 1913.
[96] Beal, "Food of Bobolinks, Blackbirds and Grackles," *U. S. Biol. Surv., Bull.* 13, 8, 1900.
[97] McAtee, *Auk*, XXXVI, 430-431, 1919.
[98] Beal, *U. S. Biol. Surv., Bull.* 54, 17, 1898.
[99] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 13, 1883.

40 winter stomachs contained only 1; 4 in February and March and 3 in July and August each contained 1.[100]

The Red-winged Blackbird (*Agelaius phoeniceus,* various subspecies); though subsisting extensively on weed seeds, which constitute 75% of their food during the cold half of the year, locally they do considerable damage,[101] because of their abundance and gregarious habits. In 1905 it was estimated that there were from 15,000,000 to 20,000,000 of these birds northwest of Wichita, Kansas, endangering agriculture; but in the 24 days from egg to maturity, the young were estimated to destroy 9,400,000 pounds of insects, or they might destroy 6,300,000,000 cutworms.[102] Not found harmful to grain at Marshall Hall, Maryland, in 1902.[103] One contained 1,800 ragweed seeds.[104] Two Illinois stomachs; ½ of food insects, ½ wheat and seeds; Lepidoptera, 27%, mostly cutworms; Coleoptera, 11%; grasshoppers, 10%; Hemiptera, traces.[105] Florida stomachs contained Lepidoptera, Coleoptera and seeds.[106] In the South, of 63 stomachs, mostly autumn and winter, 2 contained cotton-boll weevils; of 50 spring stomachs, 2 contained 1 cotton-boll weevil each.[107]

Thick-billed Redwing (*A. p. fortis*); during an invasion of box-elder leaf rollers in Colorado, Redwings gathered in numbers about the trees and fed upon the larvæ each season, and in two or three years cleaned them out.[108]

Yellow-shouldered Blackbird (*A. xanthomus*); 55 stomachs, Porto Rico; animal matter, 90.1%, including many harmful insects; Orthoptera, 1.95%; earwigs, 1.37%; Homoptera, 5.7%; other bugs, 3.36%; cane root-boring weevils, 1.72%; other weevils, 14.20%; Cerambycidæ, 0.81%; miscellaneous

[100] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905. Howell, *ibid., Bull.* 25, 12, 1906; *Bull.* 29, 18, 1907.
[101] Judd, Yearbook, *U. S. Dept. Agric. for* 1898, 230.
[102] Sullivan, *Economic Value of Bird Life,* 34, 1912.
[103] Judd, *U. S. Biol. Surv., Bull.* 17, 95-96, 1902.
[104] Allen, *Cornell Reading Courses,* IV, No. 76, 1914.
[105] Forbes, *Bull. Ill. Lab. Nat. Hist.,* I, No. 1, 13, 1881.
[106] Baker, *Proc. Acad. Nat. Sci. Phila.,* XLI, 269, 1889.
[107] Howell, *U. S. Biol. Surv., Bull.* 25, 12; *Bull.* 29, 18. Bailey, *U. S. Biol. Surv., Bull.* 22, 16.
[108] Cooke, Ann. Rept. Colo. State Board of Hort. for 1898, 50.

Coleoptera, 16.79%; caterpillars, 28.32%; Hymenoptera, 1.03%; Diptera, 3.65%; spiders, 7.83%; snails, 1.56%; miscellaneous animal matter, 0.43%; vegetable matter, 9.9%; corn, 5.73%; grass and other seeds, etc., 3.71%.[109]

Meadowlark (*Sturnella magna*, several subspecies); feed largely on noxious insects in the summer and on seeds of ragweed, pigeongrass and other weeds in the autumn, seeds forming 75% of the food in December.[110] In 1,514 stomachs (1,202 *S. magna* and subspecies, 312 *S. neglecta*) from 36 states and the District of Columbia, animal matter, 74.22%; weevils, 4.94%; beetles, 25.46%, ½ harmful species; grasshoppers and crickets, 26.08% (found in 53% of the stomachs); caterpillars, 10.54% for the year, 24.49% for May; vegetable matter, 25.78%; grain, 13.70%; weed seeds, 7.97%; a little fruit; miscellaneous vegetable matter, 3.49%; total of noxious insects and weed seeds, 64.06%; very useful nearly everywhere; where they do some damage, because over-abundant, the good they do over-balances the evil.[111] In 238 stomachs, grasshoppers and crickets, 29% for the year, 69% in August; ants, 3%; arachnids, 5%; bugs, 4% for the year, 14% in March; in 1 square mile they destroy 30,000 grasshoppers in 1 month, saving the farmers $356.00 worth of hay at 1896 prices (much higher value now); 1 contained 54 grasshoppers; another, 37.[112] In the South, of 87 February and March stomachs, 11 contained 15 cotton-boll weevils; of 249 autumn stomachs, 40 contained 50 boll weevils.[113] Southern Meadowlark (*S. m. argutula*); Florida stomachs contained insects and seeds.[114] Of 30 stomachs, 5 contained 6 cotton-boll weevils.[115]

[109] Wetmore, *U. S. Dept. Agric., Bull.* 326, 114, 1916.
[110] Judd, Yearbook, *U. S. Dept. Agric. for* 1898, 431.
[111] Beal, "Our Meadowlarks in Relation to Agriculture," Yearbook *U. S. Dept. Agric. for* 1912, 279-284; *Yearbook for* 1895, 419-430; *Farmers' Bull.* 630, 14-15, 1915. Dutcher, *Nat. Assn. Aud. Soc., Educ. Leaflet No.* 3.
[112] Beal, Yearbook *U. S. Dept. Agric. for* 1896, 419-426; *Farmers' Bull.* 54, 21-23, 1898. *Farmers' Bull.* 513, 19, 1913. Sullivan, *Economic Value of Bird Life*, 26, 1912.
[113] Howell, *U. S. Biol. Surv., Bull.* 29, 18, 1907; *Bull.* 25, 11, 1906. Bailey, *Bull.* 22, 16, 1905.
[114] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 269, 1889.
[115] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905.

Western Meadowlark (*S. neglecta*); when coulee crickets were devastating fields near Adrian, Washington, Meadowlarks appeared in great numbers and fed upon the crickets so effectively that the 1919 campaign against the crickets was abandoned.[116] Of 64 southern stomachs, 12 contained 18 cotton-boll weevils; of 153, 23 contained 26 of the weevils.[117]

Orchard Oriole (*Icterus spurius*); 11 stomachs, May and June; animal matter, 91%; beneficial insects, 2%; injurious insects, 38%; balance neutral; vegetable matter, 9%, nearly all mulberry.[118] Two stomachs from a canker-infested orchard; cankerworms, 77%; other caterpillars, 20%; ants, 3%.[119] Of 84 southern stomachs, 26 contained 47 cotton-boll weevils; 30% of them contained these weevils in summer, 64 of them in 30 birds.[120] Baltimore Orioles (*I. galbula*); 113 stomachs; animal matter, 83.4%; insects in May, 92%; in April and July, 70%; lowest in November, but 1 November bird from Connecticut contained 98%; caterpillars, 34%; click beetles, 4.5%; predacious beetles, only 0.5%; wasps, 11%; bugs, 6%; aphids in 4; scale insects in 8; grasshoppers and locusts, 1% in June, 11% in July, 17% in August; spiders, 6% for the season, 12% in August; vegetable matter, 16%.[121] Does some harm to fruit, but very little was found in 100 stomachs, mostly wild fruit.[122] Three stomachs from a canker-infested orchard in Illinois; cankerworms, 40%; Coleoptera, 60%, 52% being vine leaf-hoppers.[123] One Maryland stomach, May; mulberries, 2 wasps, 2 fall webworms, 1 click beetle, 15 leaf-mining beetles.[124] Of 50 southern stomachs, 11 contained 24 cotton-boll weevils and 1 contained 9 of them.[125]

[116] Burrill, *California Fish and Game*, VI, 38, 1920.
[117] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905.
[118] Judd, *U. S. Biol. Surv., Bull.* 17, 96, 1902.
[119] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 3, 14, 1903.
[120] Howell, *U. S. Biol. Surv., Bull.* 25, 10, 1906; *Bull.* 29, 16, 1907.
[121] Beal, Yearbook *U. S. Dept. Agric. for* 1896, 429-430; *Farmers' Bull.* 54, 23, 1898; *Farmers' Bull.* 630, 13, 1915.
[122] Beal, Yearbook *U. S. Dept. Agric. for* 1900, 298.
[123] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 14, 1883.
[124] Judd, *U. S. Biol. Surv., Bull.* 17, 96, 1902.
[125] Howell, *U. S. Biol. Surv., Bull.* 29, 16, 1907; *Bull.* 25, 10, 1906. Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905.

Bullock Oriole (*I. bullocki*); in New Mexico, seen eating caterpillars that defoliate willows and wild plum trees.[126] Of 144 southern stomachs, 27% contained cotton-boll weevils, 40 containing 133 of the weevils.[127] Porto Rican Oriole (*I. portoricensis*); 71 stomachs, Porto Rico; animal matter, 99.84%; earwigs, 24.36%; mole crickets, 0.21%; other Orthoptera, 7.2%; cicadas, 7.56%; other bugs, 1.3%; weevils, 14.67%; other Coleoptera, 4.25%; caterpillars and moths, 4.3%; ants, wasps and wild bees, 2.44%; flies, 0.22%; spiders and scorpions, 31.67%; tree toads and a lizard, 1.06%.[128]

Brewer Blackbird (*Euphagus cyanocephalus*); prefers insects to fruit, leaving cherries for insects when plowing began in neighboring fields.[129] Nestlings; insects and arachnids, 89%, mostly grasshoppers, caterpillars and spiders.[130] This species aided in the suppression of an outbreak of butterflies in California, the butterflies at the time forming 93% of its food; 1 bird estimated to destroy 100,000 butterflies in a month.[131] Of 10 southern stomachs, 5 contained 11 cotton-boll weevils.[132] These Blackbirds have at least twice been seen killing young birds of the Finch family—Goldfinches and Brewer Sparrows.[133] A few developed the habit of killing young Pheasants; when the few killers were shot the depredations ceased.[134]

Purple Grackle (*Quiscalus quiscula quiscula*); for a discussion of its food, see tables on preceding pages, as well as the publications cited in the footnote.[135] Florida Grackle (*Q. q. aglaeus*); food in Florida stomachs wholly berries of

[126] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 40, 1901.
[127] Howell, *U. S. Biol. Surv., Bull.* 25, 11, 1906; *Bull.* 29, 16, 1907.
[128] Wetmore, *U. S. Dept. Agric., Bull.* 326, 115-116, 1916.
[129] Beal, Yearbook *U. S. Dept. Agric. for* 1904, 248.
[130] Beal, *Farmers' Bull.* 630, 12-13, 1915.
[131] Bryant, *Investigations of Economic Status of Non-game Birds*, 8, 1912; *Condor*, XIII, 201-202, 1911; *Auk*, XXIX, 416, 1912.
[132] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905. Howell, *U. S. Biol. Surv., Bull.* 25, 11, 1906; *Bull.* 29, 17, 1907.
[133] Anthony, *Condor*, XXV, 106, 1923.
[134] Finley, *Condor*, XXV, 179-180, 1923.
[135] Beal, "Crow Blackbirds and their Food," Yearbook, *U. S. Dept. Agric. for* 1894, 233-248; *Farmers' Bull.* 54, 25-26, 1910; *Farmers' Bull.* 630, 12, 1915. Judd, Yearbook *U. S. Dept. Agric. for* 1898, 230. *Farmers' Bull.* 513, 17, 1913. Garman, "The Food of the Crow Blackbird," *Kentucky Agric. Exper. Sta., Bull.* 130, 19-41, 1907.

Chamærops palmetto.[136] Bronzed Grackle (*Q. q. æneus*); 3 stomachs, Illinois; corn, 62%; Coleoptera, 30%, ½ Carabidæ, 8% *Dorcus*.[137] Of 34 southern stomachs, 5 contained 1 cotton-boll weevil each.[138] Boat-tailed Grackle (*Megaquiscalus major major*); Florida stomachs contained Coleoptera and berries of *Chamærops palmetto*.[139] Great-tailed Grackle (*M. m. macrourus*); of 39 stomachs, 3 contained 1 cotton-boll weevil each; of 10 stomachs, 2 contained 4 of the weevils; 1 contained about 100 of them.[140]

Porto Rican Blackbird (*Holoquiscalus brachypterus*); 98 stomachs, Porto Rico; animal matter, 93.38%; mole crickets, 0.21%; other Orthoptera, 19.34%; bugs, 6.45%; cane root-boring weevils, 9.69% for the year, 26.67% in April, 32.13% in May; stalk-boring weevils, 5.44%; other Coleoptera, 5.32%; Lepidoptera, 11.15%; Diptera, 0.16%; Hymenoptera, 1.11%; some arachnids; snails, 6.02%; amphibians, 5.74%; lizards, 16.04%; corn, 2.19%; weed seeds, etc., 2.96%; vegetable rubbish, 1.45%.[141]

Family Fringillidæ. *Finches, Sparrows, etc.*

With their stout, conical bills, the members of this large family are especially adapted to a diet of hard seeds that most other birds cannot well eat. As destroyers of weed seeds, many of the Sparrows and Finches render efficient aid to agriculture. It has been estimated that they thus save $89,260,000 to the farmers of the United States in a single year. Judd says that investigations "amply demonstrate the value of these birds to the agriculturist—a value greater than that of any other group of birds whose economic status has thus far been investigated"; visits to the fields in winter "will often show

[136] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 270, 1889.
[137] Forbes, *Bull. Ill. Lab. Nat. Hist.*, I, No. 6, 14, 1883.
[138] Howell, *U. S. Biol. Surv., Bull.* 29, 17, 1907.
[139] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 270, 1889.
[140] Howell, *U. S. Biol. Surv., Bull.* 29, 18, 1907; *Bull.* 25, 12, 1906. Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905. *Farmers' Bull.* 513, 5, 1913.
[141] Wetmore, *U. S. Dept. Agric., Bull.* 326, 118, 1916.

that more than nine-tenths of the seeds produced have been destroyed" by the birds; weed seeds constitute ½ their food for the year, ⅘ for the cold months; grain, only 5% of all their food; cultivated fruit, very little; they distribute few, if any, noxious seeds, all seeds in the stomachs being crushed or broken; if they cause a decrease in the number of weeds of only 1%, it would amount to a net saving of $17,000,000; 1 Snowflake contained 1,500 amaranth seeds; 1 Nuttall Sparrow, 300 lamb's-quarter seeds; 1 Field Sparrow, 100 crab-grass seeds.[142] "These birds are little weeders whose work is seldom noted but always felt"; their food during the cold half of the year is almost entirely weed seeds, as shown by the examination of 4,000 stomachs.[143]

Most of the species are also somewhat insectivorous, many of them highly so when they are feeding their young and insects are abundant, and the nestlings of most species are fed exclusively on insects. In an uprising of cankerworms, 3 species of these birds destroyed from 16% to 43% of the worms.[144] They are special enemies of weevils. Five species were found to contain cotton-boll weevils, so destructive in the South.[145] Three species were found to be particularly effective against the imported alfalfa weevil in Utah.[146] Seven species, 47 stomachs, from a canker-infested orchard; seeds, 7%; insects, 91%; cankerworms, 40%; vine-leaf chafers, 6%; predacious beetles, only 2%.[147] The food of Field, Song, Chipping and Grasshopper Sparrows in Maryland is ½ insects from May to September.[148] Half the food of the adult Rose-breasted Grosbeaks, ⅔ that of the Black-headed and Blue Grosbeaks, ¼ that of the Gray Grosbeaks and Cardinals, consists of insects, while their young are at first fed entirely

[142] Judd, "The Relation of Sparrows to Agriculture," *U. S. Biol. Surv., Bull.* 15, 4, 11, 23-25, 27, 29, 49, 1901.
[143] Judd, "Birds as Weed Destroyers," Yearbook *U. S. Dept. Agric. for* 1898, 223-232.
[144] Judd, *U. S. Biol. Surv., Bull.* 15, 23-24, 1901.
[145] Howell, *U. S. Biol. Surv., Bull.* 25, 12, 1906.
[146] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 1914.
[147] Forbes, *Bull. Ill. Lab. Nat. Hist.*, I, No. 6, 13, 1883.
[148] Judd, *U. S. Biol. Surv., Bull.* 17, 97-98, 1902.

	Months	Number of stomachs	Food percentages, fractions omitted											
			Diptera	Undifferentiated Coleoptera	Alfalfa weevils	Ground beetles	Caterpillars	Grasshoppers	Cicadas	Plant Lice	Undifferentiated Hemiptera	Spiders	Weed seeds	Grain
House Finch, Carpodacus mexicanus frontalis	....	9	..	..	x	..	15	x	..	..	..	..	..	..
Western Vesper Sparrow	May	4	..	..	40	..	8	..	..	..	..	..	42	11
Pooecetes gramineus confinis	June	19	..	..	60	..	x	x	7	..	..	..	x	x
	July	44	..	..	52	4	5	..	4	..	..	..	22	4
Western Savannah Sparrow	May	7	..	..	72	..	x	..	x	..	..	..	..	..
Passerculus sandwichensis alaudinus	June	5	..	..	37	..	30	..	..	..	..	20	..	..
	July	9	..	..	30	..	5	..	..	..	7	..	2	..
Western Lark Sparrow	May	14	..	..	24	..	7	..	..	..	..	..	21	41
Chondestes grammacus grammacus	June	6	..	..	31	..	14	14	..	..	..	..	..	33
	July	11	..	..	30	..	16	..	..	..	..	..	5	45
	Aug.	1	..	..	8	..	..	..	..	..	..	..	..	92
White-crowned Sparrow														
Zonotrichia leucophrys leucophrys	....	1	..	..	x	..	..	..	..	..	..	..	..	..
Western Chipping Sparrow	May	1	..	..	x	..	..	..	..	..	..	..	..	..
Spizella passerina arizonae	June	1	..	..	98	..	..	..	..	..	..	..	..	..
	July	6	..	..	76	..	..	x	..	..	..	..	..	..
Brewer Sparrow	May	14	..	..	43	..	7	..	..	..	..	..	1	..
Spizella breweri	June	15	..	..	64	..	14	..	..	..	..	6	..	..
	July	17	..	..	44	..	11	..	..	..	9	2	x	..
Desert Song Sparrow	April	11	12	11	7	..	7	..	..	..	..	..	31	16
Melospiza melodia fallax	May	2	..	x	49	..	x	..	..	..	..	..	..	..
	June	1	..	x	66	..	x	..	..	x	..	..	x	x
Lincoln Sparrow. M. lincolni lincolni	April	3	..	x	8	..	..	..	..	..	..	..	x	..
Spurred Towhee	April	2	..	..	..	..	..	..	..	..	..	..	..	..
Pipilo maculatus montanus	....	..	..	x	6	..	..	..	..	..	..	..	x	..
Green-tailed Towhee	May	1	..	x	35	..	..	..	..	..	x	..	x	..
Oberholseria chlorura	June	4	..	x	57	..	..	..	..	..	x	..	..	..
Black-headed Grosbeak	May	1	..	x	x	..	..	..	..	..	..	..	..	..
Hedymeles melanocephalus	June	3	..	x	37	..	..	..	x	..	..	..	x	..
Nestlings	....	4	..	x	88	..	..	..	..	..	..	..	..	..
Lazuli Bunting. Passerina amoena	....	3	..	..	39	..	..	x	x	..	..	..	x	..
English Sparrow. Young, May, June, July	....	1039	..	..	17	..	10	13	..	..	..	..	..	44
Passer domesticus Adults	April	x	..	x	1	..	..	..	..	..	..	..	3	95
	May	63	..	..	8	..	..	..	..	..	..	..	3	87
	June	20	..	..	29	..	..	..	..	..	..	..	3	35

on insects; 1 Blue Grosbeak contained 16 and another 14 locusts.[149]

In 1890, 1901, 1903 and 1907, widespread and disastrous outbreaks of an imported aphis caused great injury to wheat fields, so that the crop was millions of bushels short. Stomachs of various birds shot about the fields show that the following percentages of their food consisted of aphids; Goldfinch, 82.75%; Vesper Sparrow, 19.5%; Savannah Sparrow, 25.3%; Chipping Sparrow, 94.76%; Field Sparrow, 96%; Slate-colored Junco, 5.2%; Song Sparrow, 70%.[150]

The table on the opposite page is compiled from Kalmbach's report [151] on the relation of birds to the imported alfalfa weevil in Utah, fractions of percentages being omitted, the "x" denoting food taken but no percentages stated.

The table on next page is compiled from Gabrielson's minutely detailed report on the food of winter birds,[152] fractions of percentages being omitted, the "x" denoting presence of food in stomachs but no percentages stated.

The table on page 247 is compiled from Beal's detailed report on the relation of California birds to the fruit industry,[153] fractions of percentages being omitted and the "x" denoting presence of food in stomachs but no percentage stated.

The table on page 248 is compiled from Judd's report on Sparrows in relation to agriculture,[154] the "x" denoting presence of certain food in stomachs but no percentages stated.

The table on page 249 has been compiled from Aughey's report on the food of Nebraska birds.[155]

[149] McAtee, "Food Habits of the Grosbeaks," *U. S. Biol. Surv., Bull.* 32, 1908; "Our Grosbeaks in their Relation to Agriculture," *U. S. Dept. Agric., Farmers' Bull.* 456, 1911. Beal, *U. S. Biol. Surv., Bull.* 34, 84, 93-96, 1910.

[150] McAtee, Yearbook *U. S. Dept. Agric. for* 1912, 397-404.

[151] Kalmbach, "Birds in Relation to the Alfalfa Weevil," *U. S. Dept. Agric., Bull.* 107, 1914.

[152] Gabrielson, "Food Habits of Some Winter Bird Visitants," *U. S. Dept. Agric., Bull.* 1249, 1924.

[153] Beal, "Birds of California in Relation to the Fruit Industry," *U. S. Biol. Surv., Bull.* 34, 1910.

[154] Judd, "The Relation of Sparrows to Agriculture," *U. S. Biol. Surv., Bull.* 15, 1901.

[155] Aughey, 1st Rept. *U. S. Entom. Com.*, 1878.

Number of stomachs		127	394	243	52	557	11	291	461	656	30	40	19
	Seasons	Evening Grosbeak	Pine Grosbeak	Crossbill	White-winged Crossbill	Redpoll	Hoary Redpoll	Pine Siskin	Snow Bunting	Lapland Longspur	Smith Longspur	Chestnut-collared Longspur	McCown Longspur
		Food percentages, fractions omitted											
Vegetable matter	Winter	100	99	98	93	..	..	86	96	96	62	68	..
	Summer	79	83	81	..	75	..	71	70	52			80
Weed seeds	Winter	..	7	x	9	51	x	24	35	13	1	8	..
	Summer	..	19	..	..	x	..	19	34	..			11
Grass seeds, many pernicious species	Winter	..	..	..	..	11	..	..	31	71	52	35	..
	Summer	..	..	..	..	x	..	..	28	12			10
Sedge seeds	Winter	..	..	..	..	..	..	..	8	10	..	..	..
	Summer	..	..	..	..	..	..	..	7	4	..	..	25
Conifer seeds	Winter	14	4	96	76	..	..	23	..	..	..	..	..
	Summer	28	12	68	..	..	..	20	..	..	..	..	..
Seeds of deciduous trees	Winter	37	..	..	..	34	x	18	..	..	..	..	..
	Summer	2	..	..	..	..	..	..	..	..	..	..	..
Miscellaneous seeds	Winter	x	..	..	..	..	..	20	..	..	..	x	..
	Summer	..	..	..	..	..	..	..	..	27	..		16
Wild fruits	Winter	39	31	..	x	x	..	..	..	..	..	..	..
	Summer	37	32	4	..	..	..	..	..	..	..	..	..
Mast	Winter	x	5	x	..	..	..	..	..	..	..	..	..
	Summer	..	..	..	..	..	..	..	..	..	..	..	..
Grain	Winter	..	..	..	..	..	..	..	17	9	5	21	..
	Summer	..	..	..	..	..	..	..	..	..			15
Buds	Winter	..	24	3	..	..	..	..	..	..	..	..	..
	Summer	..	x	..	..	..	..	..	..	..	..	..	..
Animal matter	Winter	..	..	1	99	..	..	13	3	3	37	31	..
	Summer	20	16	18	25	..	..	28	29	47			19
Coleoptera	Winter	x	x	..	..	..	..	..	x	..	25	6	..
	Summer	..	x	2	..	..	..	..	3	11			7
Hymenoptera	Winter	..	x	..	..	..	..	..	..	..	..	..	..
	Summer	..	x	x	..	x	..	..	..	..	..	..	..
Hemiptera, mostly plant lice	Winter	x	..	..	..	..	..	2	x	..	..	4	..
	Summer	..	..	6	..	..	..	8	..	x	..		..
Diptera	Winter	..	x	x	..	..	..	..	..	..	..	..	..
	Summer	..	x	..	..	x	..	..	..	17	..	..	..
Caterpillars	Winter	11	..	x	1	..	..	7	x	..	7	5	..
	Summer	..	x	8	..	..	..	..	..	x			..
Orthoptera	Winter	..	..	..	..	..	..	..	..	..	3	13	..
	Summer	x	..	..	..	..	..	..	..	..			6
Miscellaneous insects	Winter	..	..	..	x	..	..	2	..	..	..	x	..
	Summer	..	..	..	..	..	..	x	25	x	..		5
Spiders	Winter	..	..	x	..	..	..	..	x	..	x	x	..
	Summer	..	x	..	..	x	..	x	x	x			..

As the various species of Grosbeaks do not belong together in a systematic discussion, they will be found discussed in their proper order. Evening Grosbeak (*Hesperiphona vespertina vespertina*); of little practical importance, because not usually common in well-populated regions. In Michigan, in winter, it feeds largely on seeds of maple, box-elder, ash

Number of stomachs	17	225	399	139	321	269	96	184	516	50	84
	Black-headed Grosbeak-nestlings	Black-headed Grosbeak	Towhees-Pipilo crissalis and senicula	Towhees-Pipilo maculatus, various subspecies	Song Sparrow several subspecies	Junco hyemalis several subspecies	Western Chipping Sparrow	Golden-crowned Sparrow	Gambel and Nuttall Sparrows	Green-backed Goldfinch	Willow Goldfinch
	Food percentages, fractions omitted										
Vegetable matter	..	43	85	76	79	76	55	99	92	98	95
Weed seeds	..	14	51	34	73	61	53	33	73	96	91
Grain	..	..	28	4	3	8	1	26	8	x	x
Fruit, partly wild	..	30	4	17	2	11	x	1	4	x	..
Buds and flowers	..	..	..	..	..	x	..	29	x	x	..
Mast	..	..	x	15	..	..	..	..	..	..	..
Animal matter	100	57	14	24	21	24	45	x	7	2	5
Coleoptera	x	x	5	10	6	5	6	..	1	x	..
Orthoptera	..	x	2	..	x	x	..	..	..	..	..
Hemiptera, mostly plant lice	..	21	1	14	2	x	7	..	x	x	2
Hymenoptera	x	2	2	6	3	2	11	x	1	x	..
Lepidoptera	98	7	3	3	4	9	14	..	3	x	3
Diptera	..	x	x	..	2	..	3	..	..	x	x
Miscellaneous insects	..	x	x	x	..	..	..	x	..	..	..
Myriapods and arachnids	..	x	x	x	..	..	..	x	..	..	..
Snails	..	..	x	..	x	..	..	..	..	..	..

and conifers, and dried fruits on trees and vines; 2 in captivity for nearly 2 years ate oats only when hard-pressed by hunger and refused all insects offered them.[156] Western Evening Grosbeak (*H. v. montana*); 1 California stomach; full of willow buds.[157] I have observed that in Colorado they are very partial to box-elder seeds, a habit noted also in New Mexico by Cockerell.[158]

Pine Grosbeak (*Pinicola enucleator leucura* and other subspecies); of little economic importance, because of scarcity and remote habitat.[159] Feed largely on conifer buds, but also buds and seeds of other trees and vines.[160]

Purple Finch (*Carpodacus purpureus purpureus*); 1 February stomach contained only cedar berries.[161] Does much dam-

[156] Barrows, *Michigan Bird Life*, 466, 1912.
[157] Emerson, *Condor*, III, 18, 1901.
[158] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 52, 1901.
[159] McAtee, *U. S. Biol. Surv., Bull.* 32, 5, 1908.
[160] Barrows, *Michigan Bird Life*, 467, 1912.
[161] Judd, *U. S. Biol. Surv., Bull.* 17, 97, 1902.

	Number of stomachs	Food percentages: Vegetable matter	Animal matter	Weed seeds	Grass seeds, including many pernicious species	Sedge seeds	Grains, largely waste	Fruits, mostly wild	Coleoptera	Orthoptera	Hemiptera	Hymenoptera	Lepidoptera	Diptera	Miscellaneous insects	Myriapods and arachnids	Snails
Snow Bunting	40	100	.. 6	50	1	.. x	x	..	.. x	.. x	..	..	.. x	..	..	.. x	..
Lapland Longspur	113	94	31	19	48	x	27	..	x	11	1	1	5	..	..	x	..
Vesper Sparrow, 2 subspecies	130	69	31	42	16	..	11	..	12	11	1	1	5	..	..	..	..
Ipswich Sparrow	56	..	..	x	x	..	..	x	x	..	x	x	x	x	..	..	x
Savannah Sparrow, 2 subspecies	119	54	46	22	31	..	x	x	15	8	2	5	9	..	4	4	x
Grasshopper Sparrow	170	37	63	7	17	11	2	x	9	23	1	..	14	..	10	6	x
Henslow Sparrow	7	..	..	x	x	..	..	x	x	7	x	..	x	..	..	..	x
Sharp-tailed Sparrow, 3 subspecies	51	19	61	..	x	..	..	..	6	7	12	14	3	5	..	..	..
Seaside Sparrow	30	..	..	..	..	..	..	..	..	..	..	..	..	..	41	10	..
Lark Sparrow, 2 subspecies	167	73	27	30	21	..	15	..	..	14	..	..	..	..	13	..	..
Harris Sparrow	100	92	8	48	9	..	10	25	..	..	..	..	..	..	x	x	x
White-crowned Sparrows, 3 subspecies	217	75	25	51	4	..	15	5	5	1	1	6	9	..	1	1	..
White-throated Sparrow	217	81	19	50	..	..	3	28	5	..	1	6	3	1	..	1	1
Tree Sparrow, 2 subspecies	517	98	2	49	43	..	1	..	x	x	x	x	x	..	..	x	x
Chipping Sparrow, 2 subspecies	250	62	38	10	48	..	4	..	11	10	x	x	9	..	8	x	x
Field Sparrow, 2 subspecies	175	59	41	4	51	..	4	..	13	6	x	x	4	x	..	x	x
Junco hyemalis, various subspecies	299	78	22	..	..	..	..	..	3	2	7	3	2	..	..	1	..
Song Sparrow, various subspecies	401	66	34	37	24	..	5	x	9	7	3	4	6	2	1	..	1
Lincoln Sparrow	31	58	42	29	27	..	2	..	x	..	x	x	x	x	..	2	..
Swamp Sparrow	72	53	47	..	..	..	..	..	x	2	x	x	9	x	..	..	..
Fox Sparrow	127	86	14	..	1	..	..	28	x	..	x	..	..	..	x	x	..
Dickcissel, May to August	152	30	70	..	..	..	..	3	15	41	..	2	8	x	..	x	..
English Sparrow: Adults	80	98	2	17	7	..	74	..	..	..	x	..	..	..	..	..	..
Nestlings	50	35	65	..	..	..	33	..	8	49	1	3	4	..	..	..	..

	Number of stomachs	Grasshoppers	Average number of locusts	Locust eggs	Average number of beetles	Average number of other insects	Insect larvæ	Seeds
Evening Grosbeak. Hesperiphona v. vespertina	1	..	2	..	..	..	..	many
Pine Grosbeak. Pinicola enucleator, subsp.	5	..	..	x	..	..	..	x
Purple Finch. Carpodacus p. purpureus	1	..	..	x	..	..	..	..
Gray-crowned Rosy Finch. Leucosticte tephrocotis tephrocotis	2	..	1	..	..	..	..	x
Red-poll. Acanthis linaria linaria	4	..	x	..	..	..	..	x
Goldfinch. Astragalinus tristis tristis	3	..	6	..	..	..	..	..
English Sparrow. Passer domesticus	6	..	..	x	..	..	..	x
Lapland Longspur. Calcarius l. lapponicus	5	..	..	x	..	..	..	..
Chestnut-collared Longspur. C. ornatus	6	..	14	..	..	..	..	many
McCown Longspur. Rhynchophanes mccowni	2	..	5	..	x	..	..	..
Vesper Sparrow. Pooecetes gramineus gramineus	5	..	13	..	..	..	..	x
Grasshopper Sparrow. Ammodramus savannarum australis	7	..	9	..	x	..	..	x
Henslow Sparrow. Passerherbulus h. henslowi	1	..	13	..	x	..	..	many
Western Lark Sparrow. Chondestes grammacus strigatus	6	..	15	..	..	11	..	..
Harris Sparrow. Zonotrichia querula	1	..	14	..	5	..	x	many
White-crowned Sparrow. Z. l. leucophrys	1	..	11	..	..	x	..	..
White-throated Sparrow. Z. albicollis	5	..	30	..	..	14	..	..
Tree Sparrow. Spizella m. monticola	1	..	13	..	..	..	x	many
Chipping Sparrow. S. passerina passerina	1	..	17	..	..	..	..	..
Clay-colored Sparrow. S. pallida	1	..	9	..	..	..	..	many
Slate-colored Junco. Junco hyemalis hyemalis	3	..	4	x	x	..	..	x
Song Sparrow. Melospiza melodia melodia	2	..	15	..	..	..	..	..
Lincoln Sparrow. M. lincolni lincolni	1	..	11	..	3	..	..	many
Towhee. Pipilo e. erythrophthalmus	3	..	11	..	x	..	..	many
Cardinal. Cardinalis cardinalis cardinalis	4	..	12	..	..	10	..	..
Rose-breasted Grosbeak. Hedymelas ludovicianus	2	..	12	..	..	..	..	..
Black-headed Grosbeak. H. melanocephalus	2	..	12	..	..	..	..	many
Blue Grosbeak. Guirica cerulea cerulea	1	3	..	..	..	12	..	many
Indigo Bunting. Passerina cyanea	2	..	5	..	4	..	..	many
Dickcissel. Spiza americana	5	..	21	..	..	7	..	..
Lark Bunting. Calamospiza melanocorys	9	..	12	..	..	..	..	..

age to buds of fruit trees, but during the summer eats many injurious insects.[162] House Finch (*C. mexicanus frontalis*); damages fruit in New Mexico.[163] Does much good where weeds are abundant and but little fruit to be damaged.[164] In Colorado it feeds largely on Russian thistle seeds and feeds its young on regurgitated dandelion and other seeds.[165]

The crossed mandibles that give to Crossbills their popular name, generally assumed to be a structural adaptation to their habit of picking the seeds from conifer cones, make

[162] Barrows, *Michigan Bird Life*, 469, 1912. Eaton, "Birds of New York," *N. Y. State Museum, Memoir* 12, 264-265, 1914. Magee, *Wilson Bulletin*, XXXVII, 167-169, 1926; says buds destroyed are excess buds and no damage is done.

[163] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 37, 1901.

[164] Beal, Yearbook *U. S. Dept. Agric. for* 1904, 246-248.

[165] Bergtold, *Auk*, XXX, 40-73, 1913.

the bill an equally effective tool in tearing apart insect galls, a job at which the American Crossbill (*Loxia curvirostra minor*), at least, is expert. One taken in January was filled with cypress and eucalyptus seeds, but others were seen feeding on pine seeds.[166] In South Carolina, in January, birds examined contained only larvæ from dead pine trees, where there were no pine seeds for them to eat.[167] At Seattle, found feeding extensively on elm aphids.[168] Lepidopterous pupæ found in their crops in Nevada.[169] Hairy caterpillars eaten by Crossbills in Vermont.[170]

Gray-crowned Rosy Finch (*Leucosticte tephrocotis tephrocotis*); in California, numbers were seen feeding upon twelve-spotted ladybirds.[171] Brown-capped Rosy Finch (*L. australis*); seen feeding on grass and weed seeds; 2 Colorado stomachs; 1 contained chickweed seeds, 80% (2,400 of them); Compositæ seeds, 15%; other seeds, 4%; insects and spiders, 1%; the other contained chickweed seeds, 35%; Compositæ seeds, 50%; other seeds, 10%; insects, 5%.[172]

Red-poll (*Acanthis linaria linaria*); in Michigan, feeds largely on seeds of birch and alder, but also takes seeds of tamarack, arbor-vitæ, grass and weeds.[173]

Goldfinch (*Astragalinus tristis tristis*); 11 stomachs, Maryland; food practically all seeds, mostly weed seeds; caterpillars in 1.[174] One from a canker-infested Illinois orchard; contained no cankerworms; seeds, 70%; harpalid beetles, 30%.[175] Probably the food of the Pale and Arkansas Goldfinches (*A. t. pallidus* and *A. psaltria psaltria*) is much the same as that of *A. t. tristis*.

[166] Emerson, *Bull. Cooper Ornith. Club* (*Condor*), I, 30, 1899.
[167] Wayne, *Auk*, V, 208, 1888.
[168] Storer, *Condor*, XXIII, 98, 1921.
[169] Miller, *Condor*, XXII, 78, 1920.
[170] Miller, *Auk*. XVI, 362, 1899.
[171] Dean, *Condor*, VII, 112, 1905.
[172] Warren, *Auk*, XXXIII, 309, 1916.
[173] Barrows, *Michigan Bird Life*, 475, 1912.
[174] Judd, *U. S. Biol. Surv., Bull.* 17, 97, 1902.
[175] Forbes, *Bull. Ill. Lab. Nat. Hist.*, I, No. 6, 11, 1883.

Greenfinch (*Chloris chloris chloris*); usually regarded as a harmless seed-eater, but, introduced into New Zealand, became a "serious nuisance to the hop grower," and "often takes quite a heavy toll from the grower of turnip and radish seed." [176]

Pine Siskin (*Spinus pinus*); two California stomachs contained 1,900 black olive scales and 300 plant lice.[177] A flock of 100 seen feeding on sawfly grubs from oak-leaf galls.[178] In Michigan they feed chiefly on seeds of cedar, arbor-vitæ, larch, tamarack and other conifers, maple, elm, weeds and grass, and in the spring they feed largely on dandelion seeds,[179] as they do also in Colorado.

The economic status of the English Sparrow (*Passer domesticus*) has probably been more thoroughly investigated and discussed than that of any other species. Only a small portion of the literature can be even referred to herein.[180] The introduction of this bird into America was a calamity. Though it undoubtedly does some good, the evil it does far outweighs the good. It is a very prolific breeder, comparatively free from epidemic diseases and destructive parasites, and its destruction by predacious enemies minimized by its habit of nesting about human habitations, hence it multiplies very rapidly when introduced into a new region.[181] These birds are filthy about their nesting sites and roosts, fill the gutters with inflammable material, do much damage locally to fruit, vegetables and grain, eat food put out for poultry unless it is protected from them, rob nests of other birds, drive away many of our most useful birds and distribute chicken and other bird

[176] Taylor, *Proc. Brit. Col. Entom. Soc.*, 1913, 39; quoting *Morning Post*. Palmer, Yearbook *U. S. Dept. Agric. for* 1898, 106.
[177] U. S. Dept. Agric., *Farmer's Bull.* 513, 5, 1913.
[178] Bassett, *Condor*, XXV, 137-138, 1923.
[179] Barrows, *Michigan Bird Life*, 497, 1912.
[180] Especially noteworthy publications are: Barrows et al., "The English Sparrow (*Passer domesticus*) in America," U. S. Div. Orn. and Mam., *Bull.* 1, 405 pages, 1889. Dearborn, "The English Sparrow as a Pest," U. S. Dept. Agric., *Farmers' Bull.* 493, 1912; "How to Destroy English Sparrows," *Farmers' Bull.* 383, 1910.
[181] Barrows, *Bull.* 1, 27-39.

mites.[182] There is some evidence that they are getting less abundant in the cities since the introduction of horseless vehicles, as their food in such localities was formerly largely derived from horse droppings.[183] The Sparrows are known to drive away such insectivorous birds as the Cuckoos, yet 1 Cuckoo contained more insects (in weight) than were found in 500 English Sparrows.[184] During the height of the canker-worm season, 39 English Sparrow stomachs contained no insects; 56 stomachs, September and October, contained none; of 307 stomachs, May to September, only 102 contained insects; of 2,500 stomachs examined, only 14% contained insects; they cause an increase of hairy caterpillars, which they do not eat, by driving away the birds that do.[185] During a grasshopper outbreak in California, 2 stomachs obtained in a wheatfield; vegetable matter, 96.5%; animal matter, 3.5%; only 1 grasshopper, 2% of total contents.[186] In 1889 it rendered good service in the control of a 17-year locust plague in New York.[187] It has been observed feeding upon larvæ of the elm beetle in Connecticut,[188] and on snails (*Helix pisana*) in a snail-infested district of California.[189] Of 413 dandelion stalks in a space 6⅙ by 3¼ feet in diameter, 358 were mutilated by English Sparrows, and in a 3-foot circle 93% were mutilated. One French investigator estimated that one Sparrow will destroy 12,000 chafers or beetles in 12 days, while another said that 1 will destroy 1,500 larvæ in 24 hours; another investigator estimated it at 500 caterpillars in a day, while another said 3,360 caterpillars in a week.[190] In England it was long ago found that 75% of the adult food of

[182] Barrows, *Bull.* 1, 78-79. Judd, *U. S. Biol. Surv., Bull.* 17, 17, 1902. U. S. Dept. Agric., *Farmers' Bull.* 513, 17, 1913. Bergtold, *Auk*, XXX, 71-73, 1921. Bowles, *Forest and Stream*, XXVI, 5, 1886.
[183] Thatcher, *Bird-Lore*, XXVI, 405-406, 1924. Bergtold, *Auk*, XXXVIII, 244-250, 1921. Anthony, *Auk*, XXXVIII, 605-606, 1921.
[184] Cooke, *Ann. Rept. Colorado State Board of Horticulture for* 1898, 50.
[185] Barrows, *Bull.* 1, 99, 100, 107-108, 121-127.
[186] Bryant, *Univ. Calif. Pub. Zool.*, XI, 9, 1912.
[187] Forbush, Mass. Dept. Agric., *Bull.* 9, 24, 1921.
[188] Wilmot, *Auk*, XXXIV, 479-480, 1917.
[189] McLean, *Condor*, XXIV, 213, 1922.
[190] Sullivan, *Economic Value of Bird Life*, 31-32, 1910.

these birds consists of grain, 10% weed seeds, 4% green peas, 3% beetles, 2% caterpillars, 1% flying insects, 5% "other things"; nestlings, not over 40% grain, 40% caterpillars, 10% beetles.[191]

Lapland Longspur (*Calcarius lapponicus lapponicus*); 43 stomachs from Kansas; millet, 63%.[192] Western Savannah Sparrow (*Passerculus sandwichensis alaudinus*); of 18 stomachs, 1 contained a cotton-boll weevil.[193] Of 57 stomachs, 4 contained 1 cotton-boll weevil each.[194] Grasshopper Sparrow (*Ammodramus savannarum australis*); 1 from a canker-infested orchard contained no cankerworms, but did contain other caterpillars; beetles, 5%; spiders, 30%; pigeon-grass seeds, 15%.[195] Santo Domingan Grasshopper Sparrow (*A. s. intricatus*); 32 stomachs, Porto Rico; Orthoptera, 24.82%; lantern flies, 1.28%; other Homoptera, 1.48%; stinkbugs, 3.75%; leaf beetles, 5.3%; other Coleoptera, 4.34%; Hymenoptera, 1.33%, mostly ants; caterpillars and moths, 14.8%; spiders, 7.75%; seeds, 34.1%, mostly of grasses, sedges and weeds, including some very pernicious species.[196]

Western Lark Sparrow (*Chondastes grammacus strigatus*); 167 stomachs, California; insects, 27%; beneficial species, only 1%; grasshoppers, 14%; seeds, 73% (grass seeds, 21; grain, 13, chiefly waste; weed seeds, 30%).[197] Of 50 stomachs from cotton districts, 1 contained a cotton-boll weevil.[198] White-crowned Sparrows (*Zonotrichia leucophrys leucophrys* and subspecies); 600 stomachs; harmful beetles, 1.4%; Hymenoptera, 1.9%, mostly ants; Hemiptera, 0.5%, including scale insects; caterpillars, 3.5%; fruit, 4.5%; grain, 8.6%; weed seeds, 74%.[199] Does a little damage to fruit, but fruit

[191] Gurney, *The House Sparrow*, London, 1885, as quoted by Barrows, Div. Orn. and Mam., *Bull.* 1, 124, 1889.
[192] Judd, U. S. Biol. Surv., Bull. 15, pp. 54-55, 1901.
[193] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905.
[194] Howell, *U. S. Biol. Surv., Bull.* 29, 19, 1907.
[195] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 12, 1883.
[196] Wetmore, *U. S. Dept. Agric., Bull.* 326, 128, 1916.
[197] Bryant, *Univ. Calif. Pub. Zool.*, XI, p. 12, 1912.
[198] Howell, *U. S. Biol. Surv., Bull.* 25, 12, 1906; *Bull.* 29, 19, 1907.
[199] Beal, Yearbook *U. S. Dept. Agric. for* 1904, 247.

buds found in only 30 out of 516 stomachs.[200] White-throated Sparrow (*Z. albicollis*); of 22 stomachs from cotton districts, only 1 contained a cotton-boll weevil.[201]

Tree Sparrow (*Spizella monticola monticola*); in winter, feeds entirely on weed seeds; estimated that Tree Sparrows in Iowa destroy over 875 tons of weed seeds annually.[202] Chipping Sparrow (*S. passerina passerina*); 300 stomachs; beetles, 11%; Hymenoptera, 11.8% (67.5% in June), mostly ants; Hemiptera, 7.5%; Diptera, 3%; caterpillars, 14.2% (43.25% in May); grain, 4%; fruit, a trace; weed seeds, 53%.[203] Eight stomachs from a canker-infested orchard; food ⅙ canker-worms, ⅙ other caterpillars; gnats, 28%; Hemiptera, 6%; Coleoptera, 28%.[204] Takes plant lice, which are neglected by most birds.[205] Parents observed to visit 1 nest 200 times in a day, bringing insects for nestlings nearly every time.[206] Field Sparrow (*S. pusilla pusilla*); 3 stomachs from a canker-infested orchard, gnats, 5%; Hemiptera, 1%; balance ¼ cankerworms, ¼ other Lepidoptera, ½ Coleoptera.[207] Western Field Sparrow (*S. p. arenacea*); of 7 stomachs from cotton districts, only 1 contained a cotton-boll weevil.[208]

Slate-colored Junco (*Junco hyemalis*); 500 stomachs; vegetable matter, 77%; grain, 8%; weed seeds, 61.8%; animal matter, 23%; Coleoptera, 6%, largely weevils; Hymenoptera, 2%, mostly ants; caterpillars, 9.4%; bugs, grasshoppers and other insects and spiders, 7.3%.[209] Red-backed Junco (*J. phœonotus dorsalis*); New Mexico stomachs contained beetles, Lepidoptera and some seeds.[210] Juncos have been observed

[200] *U. S. Dept. Agric., Bull.* 513, 16, 1913.
[201] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905. Howell, *U. S. Biol. Surv., Bull.* 25, 12, 1906; *Bull.* 29, 20, 1907.
[202] Beal, U. S. Dept. Agric., *Farmers' Bull.* 54, 28, 1898.
[203] Beal and McAtee, *Farmers' Bull.* 506, 25-26, 1912. *Farmers' Bull.* 513, 16, 1913.
[204] Forbes, *Bull. Ill. Lab. Nat. Hist.*, I, No. 6, 12, 1883.
[205] Judd, *U. S. Biol. Surv., Bull.* 17, 27, 1902; *Bull.* 15, 77, 1901.
[206] Weed, New Hampshire Agric. Exper. Sta., *Bull.* 55.
[207] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 12, 1883.
[208] Howell, *U. S. Biol. Surv., Bull.* 29, 20, 1907.
[209] Beal and McAtee, *Farmers' Bull.* 506, 26-27, 1912.
[210] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 38, 1901.

catching insects on the wing.[211] Song Sparrow (*Melospiza melodia melodia*); ¾ of diet is seeds of noxious weeds; ¼ insects, chiefly weevils and other Coleoptera, with some ants, scale insects, etc.[212] Towhee (*Pipilo erythrophthalmus erythrophthalmus*); 1 stomach, September, contained 1 locust, 1 beetle, 1 weevil, 1 bug, 1 cricket, 6 ants and some seeds.[213] Of 6 Texas stomachs, 1 contained a cotton-boll weevil.[214]

The following table is compiled from McAtee's very minutely detailed report on the food of Grosbeaks: [215]

Number of stomachs	498	74	176	226	51
	Cardinal Cardinalis cardinalis cardinalis, various subspecies	Gray Grosbeaks Pyrrhuloxia sinuata, various subspecies	Rose-breasted Grosbeak Hedymeles ludovicianus	Black-headed Grosbeak Hedymeles melanocephalus	Blue Grosbeak Guiraca cærulea
	Food percentages				
Vegetable matter	71.01	71.19	48.00	34.15	32.40
Grain	8.73	....	5.09	3.91	14.25
Wild fruits	24.17	x	19.30	6.37	....
Fruits, wild or cultivated	....	....	....	4.74	0.06
Cultivated fruits	....	....	....	9.85	....
Grass seeds, including pernicious species	....	53.09	....	....	....
Weed seeds	36.33	6.13	15.74	8.74	18.05
Animal matter	28.99	28.81	52.00	65.85	67.60
Hymenoptera	0.92	x	6.43	2.56	....
Hemiptera	3.72	1.05	2.38	24.58	x
Lepidoptera	5.10	10.32	3.82	9.00	9.77
Orthoptera, mostly grasshoppers	6.42	11.52	....	....	27.20
Coleoptera	10.48	4.66	36.00	28.71	24.40
Mollusks	x	....	....	x	x

Cardinal (*Cardinalis cardinalis cardinalis*); 1 seen eating a field mouse in winter.[216] It takes Rocky Mountain locusts, periodical cicadas, Colorado potato beetles, rose chafers, cot-

[211] Murphy and Nichols, *Bird-Lore*, XVII, 134, 1915.
[212] U. S. Dept. Agric., *Farmers' Bull.* 513, 15, 1913. See also Beal, *Farmers' Bull.* 54, 26-28, 1898.
[213] Judd, *U. S. Biol. Surv., Bull.* 17, 98, 1902.
[214] Howell, *U. S. Biol. Surv., Bull.* 29, 20, 1907.
[215] McAtee, "Food Habits of Grosbeaks," *U. S. Biol. Surv., Bull.* 32, 1908.
[216] McAtee, *Bull.* 32, 5-27.

ton worms, scale insects, weevils and other destructive insects.[217] Ten Maryland stomachs; insects and spiders, 22% (beetles, 15%); vegetable matter, 78%, half fruit, half seeds.[218] Florida stomachs contained spiders and seeds of palms.[219] Three from cotton districts contained 4 cotton-boll weevils.[220] Gray Grosbeaks (*Pyrrhyloxia sinuata,* subspecies); of 64 stomachs, 2 contained 1 cotton-boll weevil each.[221]

Rose-breasted Grosbeak (*Hedymeles ludovicianus*); 2 stomachs from a canker-infested orchard; cankerworms, 5%; other caterpillars, 58%; Coleoptera, 15%; seeds, 20%.[222] It is one of the few birds that feed extensively upon Colorado potato beetles, which constitute 9.05% of its food.[223] This habit is commented upon in a great many publications. Takes also cucumber beetles, tent caterpillars, tussock, gipsy and brown-tailed moths, plum curculios, army worms, chinch bugs and many other injurious insects.[224] Black-headed Grosbeak (*H. melanocephalus*); another enemy of the potato beetle and hairy caterpillars, and 58.75% of its food consists of harmful insects.[225] One-sixth of its food consists of flower beetles; for each quart of fruit consumed by it, it destroys 1½ quarts of scale insects and other injurious insects.[226] Has been known to eat butter and bacon grease.[227] Blue Grosbeak (*Guirica cærulea cærulea*); 1 contained 16 and another 15 locusts.[228] Observed feeding on seeds of Johnson grass.[229]

Porto Rican Grosbeak (*Loxigilla portoricensis*); 26 stom-

[217] McAtee, *Farmers' Bull.* 456, 9, 1911.
[218] Judd, *U. S. Biol. Surv., Bull.* 17, 98, 1902.
[219] Baker, *Proc. Acad. Nat. Sci. Phila.,* XLI, 270, 1889.
[220] Howell, *U. S. Biol. Surv., Bull.* 25, 12, 1906; *Bull.* 29, 19, 1907.
[221] Howell, *ibid.*
[222] Forbes, *Bull. Ill. State Lab. Nat. Hist.,* I, No. 6, 13, 1883.
[223] McAtee, *U. S. Biol. Surv., Bull.* 32, 33-59, 1908. Beal, *Farmers' Bull.* 54, 29, 1898. Barrows, *Ann. Rept. U. S. Dept. Agric. for* 1888. 535-536. Sullivan, *Economic Value of Bird Life.*
[224] *U. S. Dept. Agric., Bull.* 513, 15, 1913.
[225] McAtee, *U. S. Biol. Surv., Bull.* 32, 60-77, 1908; *U. S. Dept. Agric., Bull.* 456, 9-10. Sullivan, *Economic Value of Bird Life.*
[226] U. S. Dept. Agric., *Farmers' Bull.* 513, 14, 1913. Beal, Yearbook *U. S. Dept. Agric.* for 1904, 248.
[227] Bailey, *Condor,* XVIII, 201, 1916.
[228] McAtee, *Bull.* 32, 84. Consult also McAtee, *Farmers' Bull.* 456, 11-12.
[229] Dixon, *Condor,* XVII, 204, 1915.

achs, Porto Rico; animal matter, 29.89%; orthopterous eggs, 1.17%; weevils, 14.14%; other Coleoptera, 10.42%; caterpillars, 3.07%; spiders, 0.16%; miscellaneous, 0.93%; vegetable matter, 70.11%; a few grass seeds, but chiefly seeds of wild berries and small fruits of no value to man.[230]

Indigo Bunting (*Passerina cyanea*); 18 stomachs from a canker-infested orchard; Lepidoptera, 67% (cankerworms, 59%); Coleoptera, 29%; Hymenoptera, a trace; 15 stomachs from miscellaneous situations; Lepidoptera, 28%; Coleoptera, 19%.[231] One Maryland stomach contained 1 beetle and vegetable debris.[232] Painted Bunting (*P. ciris*); 18 stomachs (16% of those examined) from cotton districts contained 1 cotton-boll weevil each, 1 containing more.[233]

Carib Grassquit (*Tiaris bicolor omissa*); 72 stomachs, Porto Rico; almost entirely gramnivorous, only 5 containing a few insects and spiders; food chiefly seeds of grasses, sedges and weeds, some of which are pernicious.[234] Bryant Grassquit (*T. olivacea bryanti*); 65 stomachs, Porto Rico; only 1 contained animal matter, a few spiders and a leaf hopper; most of the food consisted of grass seeds, including some species considered pernicious.[235]

A Galapagos Island Finch (*Geospiza heliobates*), living exclusively in mangrove swamps, where seeds are not available, "feeds entirely on insects," while its 34 relatives living on the islands "are all seed-eaters, although they occasionally pick up a few ants and other small insects."[236]

Dickcissel (*Spiza americana*); 14 stomachs from a canker-infested orchard; Lepidoptera, ⅔ of food (cankerworms 43%); Coleoptera, 22%; grain and other seeds, 6%; 12 stomachs from various situations; insects, 47%.[237] Of 26 from cotton

[230] Wetmore, *U. S. Dept. Agric., Bull.* 326, 125, 1916.
[231] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 13, 20, 1883.
[232] Judd, *U. S. Biol. Surv., Bull.* 17, 98, 1902.
[233] Howell, *U. S. Biol. Surv., Bull.* 25, 12, 1906; *Bull.* 29, 19, 1907.
[234] Wetmore, *U. S. Dept. Agric., Bull.* 326, 126, 1916.
[235] Wetmore, *ibid.*, 127.
[236] Snodgrass, *Auk*, XIX, 367, 1902.
[237] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 12, 19-20, 1883.

districts, 3 contained 1 cotton-boll weevil each.[238] In 33 stomachs, vegetable matter, 68%; animal matter, 32%; weed seeds, 36%; grain, 32%, mostly waste from stubble; grasshoppers and locusts, 28%; caterpillars, 3%; estimated that Dickcissels destroy 100,000,000 grasshoppers per day in Illinois during the nesting season, saving the state $4,680 daily by the destruction of grasshoppers alone, besides the saving from the destruction of other pests.[239]

Family Ploceidæ. *Weaver-birds*

Hooded Weaver-finch (*Spermestes cucullatus*); 33 stomachs, Porto Rico; food almost entirely seeds of grasses and sedges.[240] Scarlet-cheeked Weaver-finch (*Amandava melpoda*); 19 stomachs, Porto Rico; food chiefly grass seeds; no insects.[241]

Family Tangaridæ. *Tanagers*

Western Tanager (*Piranga ludoviciana*); 46 stomachs, California; insects, 82%; Hymenoptera, 56% (75% in August), mostly wasps and ants; Hemiptera, 8%; beetles, 12% (less than 1% useful species); grasshoppers, 4%; caterpillars, 2%.[242] One Nebraska stomach; 13 locusts and many beetles.[243] Said to have done much damage to fruit in California in 1896 during a remarkable migration "wave."[244] The young feed at first exclusively on insects.[245] Scarlet Tanager (*P. erythromelas*); 3 Maryland stomachs, May and August, contained only insects.[246] One Nebraska stomach; 37 locusts.[247]

[238] Howell, *U. S. Biol. Surv., Bull.* 25, 12, 1906.
[239] Gross, *Auk*, XXXVIII, 163-166, 1921.
[240] Wetmore, *U. S. Dept. Agric., Bull.* 326, 111, 1916.
[241] Wetmore, *ibid.*, 112.
[242] Beal, *U. S. Biol. Surv., Bull.* 30, 23-26, 1907.
[243] Aughey, 1st Rept. *U. S. Entom. Com.*, 24, 1878.
[244] Emerson, *Condor*, V, 64-66, 1903.
[245] Judd, Yearbook *U. S. Dept. Agric. for* 1900, 418-419.
[246] Judd, *U. S. Biol. Surv., Bull.* 17, 98, 1902.
[247] Aughey, 1st Rept. *U. S. Entom. Com.*, 24, 1878.

One took 630 gipsy moth caterpillars in 18 minutes.[248] Summer Tanager (*P. rubra rubra*); 1 stomach; wild blackberries, a bee and a wasp.[249]

Porto Rican Tanager (*Nesospingus speculiferus*); 29 stomachs, Porto Rico; animal matter, 59.87%; Orthoptera, 8.4%; coffee-leaf weevil, 8.5%; other weevils, 0.21%; miscellaneous beetles, 0.35%; bugs, 1.26%; moths and caterpillars, 30.94%; Hymenoptera, 1.72%, largely ants; spiders, 1.49%; snails, 0.72%; tree toads and a lizard, 6.12%; miscellaneous, 0.61%; vegetable matter, 40.13%; wild fruits, 25.7%; grass seeds, 8.27%; miscellaneous "rubbish," 6.16%; ⅔ of food consists of destructive pests.[250] Porto Rican Euphonia (*Tanagra sclateri*); 51 stomachs, Porto Rico; contained only seeds of a mistletoe that, where abundant, is injurious to trees.[251] Hence called the "Mistletoe Bird," its stomach having become so modified as to especially adapt it to extracting the nutriment from the seeds without grinding them.[252] Porto Rican Spindalis (*Spindalis portoricensis*); 96 stomachs, Porto Rico; weevils in 2; the others filled with seeds of wild fruit and berries of 20 species.[253]

Family Hirundinidæ. *Swallows and Martins*

The members of this family take most of their food on the wing, hence live almost entirely on flying insects, though nearly all the species take a few caterpillars and other wingless prey and a little vegetation, the latter, in case of the Tree Swallow, amounting to 19% of its total food.

The following table has been compiled from Aughey's report on the food of Nebraska birds:[254]

[248] Allen, *Cornell Reading Courses*, IV, No. 76, 1914.
[249] Judd, *Bull.* 17, 98, 1902.
[250] Wetmore, *U. S. Dept. Agric., Bull.* 326, 120-121, 1916.
[251] Wetmore, *ibid.*, 123-124.
[252] Wetmore, *Auk*, XXXI, 458-461, 1914.
[253] Wetmore, *Bull.* 326, *supra*, 122-123.
[254] Aughey, 1st Rept. *U. S. Entom. Com.*, 1878.

	Number of stomachs	Average number of locusts	Average number of other insects
Purple Martin, Progne subis subis	10	26	16
Cliff Swallow, Petrochelidon lunifrons lunifrons	8	30	14
Barn Swallow, Hirundo erythrogastris	7	20	19
Northern Violet-green Swallow, Tachycineta thalassina lepida	1	23	17
Bank Swallow, Riparia riparia	5	20	21

The following table, based upon the contents of 2,030 stomachs of 7 species, is reproduced from Beal's report on the food of Swallows: [255]

Number of stomachs	205	375	467	343	110	394	136	2,030
	Purple Martin Progne subis subis	Cliff Swallow Petrochelidon lunifrons lunifrons	Barn Swallow Hirundo erythrogastris	Tree Swallow Iridoprocne bicolor	Northern Violet-green Swallow Tachycineta thalassina lepida	Bank Swallow Riparia riparia	Rough-winged Swallow Stelgidopteryx serripennis	Average for the 7 species
	Food percentages							
Weevils	2.63	8.38	1.96	1.92	4.12	5.78	4.93	4.25
Other beetles	9.90	18.50	13.66	12.50	6.45	12.12	9.90	11.86
Ants	3.52	8.24	9.89	6.37	9.42	13.39	11.99	8.97
Other Hymenoptera	19.47	20.51	12.82	7.58	17.48	20.10	18.91	16.70
Hemiptera	14.58	26.32	15.10	5.59	35.96	7.96	14.90	17.20
Diptera	16.09	13.25	39.49	40.54	19.36	26.63	32.89	26.89
Lepidoptera	9.39	.46	2.39	1.07	3.12	1.21	1.11	2.68
Orthoptera	1.09	.71	.51	.38	..	.01	.12	.40
Other insects	22.87	2.56	3.72	4.25	4.09	12.64	4.48	7.80
Other animal food	.46	.41	.28	.34	..	.14	.56	.31
Vegetable food, chiefly fruits of waxberry	..	.66	.18	19.46	..	.02	.21	2.93

Thirty stomachs of 5 species from Maryland; parasitic wasps and bees, 2%; bugs, 3%; May-flies, 8%; beetles, 13%; white ants, 21%; ants, 33%; miscellaneous, mostly flies, 20%.[256]

As the Swallows and Martins are very active, requiring a

[255] Beal, "Food Habits of the Swallows, a Family of Valuable Native Birds," *U. S. Dept. Agric., Bull.* 619, 1918.
[256] Judd, *U. S. Biol. Surv., Bull.* 17, 99, 1902.

large amount of food, and a considerable part of each insect is indigestible, the number of insects they destroy in order to get sufficient nourishment is "not only beyond calculation, but almost beyond comprehension." The food is often compressed into a hard mass, so it is wonderful how much a stomach may contain. The mass of insects contained in a Swallow or Martin would, before compression, equal or exceed the bulk of the bird's body.[257] When we consider that the food in a stomach represents only 1 meal and that each bird takes several meals a day, and keep in mind the number of birds engaged in destroying insects, we may well agree with Beal's remark just quoted.

These birds are frequently accused of bringing to human habitations bedbugs, lice and other parasites of the human race, but it is well known to zoologists that the parasites infesting the nests of the birds are not the species that affect human beings.[258]

Purple Martin (*Progne subis subis*); "feeds entirely on insects."[259] A quart of wing covers of cucumber beetles were found in one Martin nesting box.[260] Two Texas stomachs each contained a cotton-boll weevil.[261] Fifteen pairs were observed feeding their young for some time entirely on dragonflies.[262] Caribbean Martin (*P. dominicensis*); 12 stomachs, Porto Rico; no vegetable food; stinkbugs, 24.17%; beetles, 7.83%, many injurious species; flies, 26.42%; Hymenoptera, 33.41%, mainly wasps; dragonflies, 8.09%.[263]

Cliff Swallow (*Petrochelidon lunifrons lunifrons*); 35 stomachs from Texas all contained cotton-boll weevils, averaging

[257] Beal, U. S. Dept. Agric., *Farmer's Bull.* 54, 31, 1898; *U. S. Biol. Surv., Bull.* 30, 27, 1907. Henshaw, "Value of Swallows as Insect Destroyers," *U. S. Biol. Surv.*, Circular 56, 1907.
[258] Henshaw, *ibid.* Howell, *U. S. Biol. Surv., Bull.* 29, 12-13, 1907. Nash, "Birds of Ontario, etc.," Rept. *Farmers' Institute of Ontario*, 29, 1897-8. Warren, "Swallows and Bedbugs," *Condor*, XV, 14-16, 1913. *Farmers' Bull.* 513, 13, 1913. Barrows, *Michigan Bird Life*, 543, 1912.
[259] Pennock, Delaware State Board of Agric., *Bull.* 5, 15, 1904.
[260] Attwater, *The Relation of Birds to the Farmer*, 9, 1902.
[261] Howell, *U. S. Biol. Surv., Bull.* 29, 14, 1907.
[262] Doolittle, *Bird-Lore*, XXI, 305-306, 1919.
[263] Wetmore, U. S. Dept. Agric., *Bull.* 326, 88, 1916.

18 each, the majority containing nothing else; estimated to destroy more than 1,000,000 of these destructive insects in a week in one Texas county.[264] One California stomach, during a grasshopper outbreak; animal matter, 100%; grasshoppers, only 7.5%.[265] In 123 stomachs, vegetation less than 1%; Hymenoptera, 39%, mostly bees and wasps, a few ants, the honey bees all drones; Hemiptera, 27%, nearly all injurious; beetles, 19% (2% useful); Diptera, 12%, mostly gnats.[266] One from a canker-infested orchard; scavenger beetles, 98%; Hemiptera, 2%.[267] Three adult Utah stomachs; alfalfa weevils, 12%; ground beetles, 40%; 17 nestling stomachs; alfalfa weevils, 1%; aquatic beetles, 16.6%.[268] Jamaican Cliff Swallow (*P. fulva poeciloma*); 36 stomachs, Porto Rico; Orthoptera, 1.39%; lantern flies, 3.47%; jumping plant lice and allies, 1.08%; stinkbugs, 7.63% (22.58% in June); chinchbugs, etc., 3.25%; leaf beetles, 8.06%; engraver beetles, 41%; other snout beetles, 1.19%; other beetles, 6.18%; flies, 16.07%; ants, 9.13%; other Hymenoptera, 2.67%.[269]

Barn Swallow (*Hirundo erythrogastris*); 82 stomachs; vegetable matter, a single seed; Hemiptera, 39% (90% in September); flies, 32%; Hymenoptera, 18% (only 1% parasitic and only 1 honey bee, a drone); beetles, 10%.[270] Of 14 Texas stomachs, 5 averaged 10 cotton-boll weevils each, 1 containing 23.[271] One stomach taken during a grasshopper outbreak in California; animal matter, 100%; no grasshoppers.[272]

Tree Swallow (*Iridoprocne bicolor*); 1 contained 40 whole chinchbugs, besides many fragments and 10 other species of insects.[273] During its southward migration it feeds freely on

[264] Howell, *U. S. Biol. Surv., Bull.* 29, 12-13, 1907. Henshaw, *U. S. Biol. Surv., Circular* 57, 1, 1907.
[265] Bryant, *Univ. Calif. Pub. Zool.*, XI, 9, 12, 1912.
[266] Beal, *U. S. Biol. Surv., Bull.* 30, 28-30, 1907.
[267] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 11, 1883.
[268] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 39-40, 1914.
[269] Wetmore, *U. S. Dept. Agric., Bull.* 326, 86, 1916.
[270] Beal, *U. S. Biol. Surv., Bull.* 30, 30-31, 1907.
[271] Howell, *U. S. Biol. Surv., Bull.* 29, 13-14, 1907.
[272] Bryant, *Univ. Calif. Pub. Zool.*, XI, 9, 12, 1912.
[273] U. S. Dept. Agric., *Farmers' Bull.* 513, p. 5, 1913.

berries of bayberry (waxberry).[274] Northern Violet-green Swallow (*Tachycineta thalassina lepida*); 74 stomachs; Hemiptera, 36%; Diptera, 29%; Hymenoptera, 23%; beetles, 11% (3% useful); moths, etc., 1%.[275] Bank Swallow (*Riparia riparia*); of 25 stomachs from cotton districts, 11 averaged 6 cotton-boll weevils each; 1 contained 14.[276] Rough-winged Swallow (*Steligidopteryx serripennis*); in Utah, during an alfalfa weevil outbreak, 5 May stomachs, weevils in 2; 8 June, weevils in 3; flies, 75%; 8 July, weevils, 23%; ants, over 50%.[277]

Family Bombycillidæ. *Waxwings*

Bohemian Waxwing (*Bombycilla garrula*); 1 Nebraska stomach contained an "immense number of locust eggs."[278] Large flocks were seen in Colorado feeding upon small fresh-water snails.[279] Observed regurgitating "Russian olive" seeds.[280] In Canada, seen feeding on mountain ash berries.[281] In 1917 a remarkable migration "wave" brought to Eastern Colorado flocks of these birds numbering many thousands. For several weeks they subsisted on apples caught on the trees by an early freeze.

Cedar Waxwing (*B. cedrorum*); 4/5 of food is fruit, remainder insects.[282] Eats cultivated fruit when wild fruits are not available.[283] The name "Cherry Bird" is a misnomer; 152 stomachs (40 taken during cherry season); vegetable matter, 87%; balance mostly insects; wild fruit, 74%; cultivated fruit, 13%; only 9 contained cherries.[284] Seven from a canker-infested orchard; cankerworms, nearly 100%; at only 1 meal

[274] Beal, *U. S. Biol. Surv., Bull.* 30, 27, 1907.
[275] Beal, *ibid.*, 32-33.
[276] Howell, *U. S. Biol. Surv., Bull.* 29, 14, 1907. *Farmers' Bull.* 513, 5, 1913.
[277] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 40-41, 1914.
[278] Aughey, 1st Rept. *U. S. Entom Com.*, 26, 1878.
[279] Lincoln, *Auk*, XXXVII, 73-74, 1920.
[280] Bergtold, *Auk*, XXXIV, 341-342, 1917.
[281] Barrows, *Michigan Bird Life*, 555, 1912.
[282] Judd, *U. S. Biol. Surv., Bull.* 17, 99, 1902.
[283] Beal, Yearbook *U. S. Dept. Agric. for* 1900, 304.
[284] Beal, *Farmers' Bull.* 54, 31-32, 1898.

a day (and they certainly take more), 30 Cedar Birds would destroy 90,000 cankerworms in a month.[285] Insect food, 17%, chiefly during the fruit season; young are fed mostly on insects.[286] One stomach contained 100 cankerworms.[287]

Family Ptilogonatidae. *Silky Flycatchers*

Phainopepla (*Phainopepla nitens*); catches insects on the wing, but also feeds extensively on seeds and fruits, being especially fond of mistletoe.[288]

Family Laniidæ. *Shrikes*

Northern Shrike or "Butcher Bird" (*Lanius borealis*); 67 stomachs; mice 25%; grasshoppers, 25%; beetles and caterpillars, 12.5%; contained 28 species of seed-eating birds; from October to April, mice and birds, 60%; insects, 40%.[289] In Minnesota in March they live almost exclusively on field mice; carrion sometimes taken.[290] One Nebraska stomach contained 14 locusts.[291] Of 7 from Texas, 2 contained 5 cotton-boll weevils.[292]

Loggerhead Shrike (*L. ludovicianus ludovicianus*); no vegetable food; insects, 68%; spiders, 4%; vertebrates, 28%; Orthoptera, 39%, mostly grasshoppers and crickets; beetles, over 16% (9% harmful); ants and wasps, 3%; moths and caterpillars, 4%; other insects, 5%; mammals, birds and reptiles, 28%, chiefly mice and shrews.[293] One killed a snake 13 inches long.[294] Another seen killing a Phoebe.[295] Only

[285] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 11, 1883.
[286] Beal, "Food Habits of the Cedarbird," Ann. Rept. *U. S. Dept. Agric. for* 1892, 197-200.
[287] Allen, *Cornell Reading Courses*, IV, No. 76, 1914.
[288] Coues, *Birds of the Colorado Valley*, 477, 479, 1878.
[289] Judd, "The Food of Shrikes," *U. S. Biol. Surv., Bull.* 9, 15-26, 1898. Allen, *Cornell Reading Courses*, IV, No. 76, 29-30, 1914.
[290] Judd, *Bull.* 9, *supra*, p. 19. Lantz, *U. S. Biol. Surv., Bull.* 31, 51, 1907.
[291] Aughey, 1st Rept. *U. S. Entom. Com.*, 28, 1878.
[292] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905.
[293] Beal and McAtee, *Farmers' Bull.* 506, 29-31, 1912. Beal, *U. S. Biol. Surv., Bull.* 30, 35, 1907. *Farmers' Bull.* 513, 13, 1913.
[294] Judd, *U. S. Biol. Surv., Bull.* 17, 100-102, 1902.
[295] Wayne, *Auk*, XXXVIII, 279-280, 1921.

7 stomachs out of 88 examined contained remains of birds, though 13 species are reported to have been killed by this Shrike; no shrews in these stomachs; 6 contained lizards; food also includes fish and snakes; 6 stomachs of half-grown young; insects, 75%, mainly grasshoppers; remains of field mice in 2, but no bird remains.[296]

White-rumped Shrike (*L. l. excubitorides*); of 54 Texas stomachs, 2 contained 5 cotton-boll weevils.[297] Three Nebraska stomachs averaged 32 locusts each, and each contained bird remains.[298] In Oklahoma, found feeding on mice, grasshoppers and English Sparrows.[299] Cockerell says it takes lizards, grasshoppers, mice and snakes.[300] Lincoln's suggestion that it is entirely insectivorous does not seem to be supported by the evidence.[301] California Shrike (*L. l. gambeli*); 124 stomachs; vegetable matter, 2.5%; fruit in 2, seeds in 2, rubbish in 6; insects, 83%; Orthoptera, 43%, mostly grasshoppers, some crickets; beetles, 16% (7% harmful); moths and caterpillars, 7% (1 contained 15 moths); ants and wasps, 11%; other insects, 5%; snails and spiders, 2%; mammals in 4, birds in 2, reptiles (mostly lizards) in 12.[302] During a grasshopper outbreak in California, 2 stomachs; animal matter, 100%; grasshoppers, 47%; 6 crickets.[303] One killed a Golden-crowned Sparrow.[304]

Family Vireonidæ. *Vireos*

The Vireos are highly insectivorous, destroying many insects that are harmful to fruit trees, etc.[305] The vegetable

[296] Judd, *U. S. Biol. Surv., Bull.* 9, 20-26, 1898. As to bird-eating, see Mounts, *Wilson Bulletin*, XXXV, 221, 1923; XXXVII, 222, 1925. Lincoln, *Auk*, XXXVII, 74, 1920.
[297] Howell, *U. S. Biol. Surv., Bull.* 25, 14-15, 1906; *Bull.* 29, 22, 1907.
[298] Aughey, *U. S. Entom. Com.*, 1st Rept., 28, 1878.
[299] Tate, *Bull. Univ. Okla.*, n. ser., No. 322, 35, 1925.
[300] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 50, 1901. See also Gignoux, *Condor*, XXIX, 75, 1927.
[301] Lincoln, *Auk*, XXXVII, 74, 1920.
[302] Beal and McAtee, *Farmers' Bull.* 506, 29-31, 1912. Beal, *U. S. Biol. Surv., Bull.* 30, 33-37, 1907.
[303] Bryant, *Univ. Calif. Pub. Zool.*, XI, 9, 1912.
[304] Richardson, *Condor*, X, 92, 1908.
[305] Beal, Yearbook, *U. S. Dept. Agric. for* 1900, 298.

food of 10 species varies from 6.7% to 14.72% and is of no economic importance, while the balance consists almost entirely of insects.[306] In the West Indies they are said to eat more berries and seeds than in the United States.[307]

The following table is modified and republished from Chapin's detailed report on the Food habits of Vireos: [308]

	Bell Vireos Vireo belli, subspecies	Hutton Vireos Vireo huttoni, subspecies	White-eyed Vireos Vireo griseus, subspecies	Blue-headed Vireos Lanivireo solitarius, subspecies	Yellow-throated Vireo Lanivireo flavifrons	Warbling Vireos Vireosylva gilva, subspecies	Philadelphia Vireo Vireosylva philadelphica	Red-eyed Vireo Vireosylva olivacea	Black-whiskered Vireo Vireosylva calidris
Number of stomachs	52	70	221	306	160	340	75	569	4
	Food percentages								
Vegetable food, economically unimportant	.70	1.77	11.76	3.68	1.74	5.76	7.22	14.72	12.50
Animal food	99.30	98.23	88.24	96.32	98.26	94.24	92.78	85.28	87.50
Scarabæidæ	..	.27	.66	1.67	1.84	1.28	6.94	3.31	..
Coccinellidæ	2.19	8.12	1.36	4.88	.62	8.74	5.03	1.29	..
Chrysomelidæ	3.98	.25	3.78	.96	.82	2.48	7.99	1.63	..
Elateridæ, Buprestidæ, Cerambicidæ	1.69	.85	2.31	3.39	3.57	1.03	.96	2.70	..
Other Coleoptera	1.31	1.01	1.46	.81	1.82	55	.47	.78	15.75
Rhynchophora	6.09	2.75	3.21	1.80	4.23	1.45	3.43	1.13	2.50
Caterpillars	15.89	12.22	20.66	22.95	23.10	35.40	24.13	32.43	11.75
Other Lepidoptera	4.74	12.33	9.83	9.31	19.35	4.99	2.17	2.76	2.50
Pentatomidæ	9.34	20.15	8.56	20.13	15.50	5.47	1.67	7.03	..
Other Hemiptera	25.09	25.73	11.71	10.29	7.62	11.24	8.79	8.33	2.75
Hymenoptera	6.44	6.30	7.23	6.86	5.07	5.97	13.96	10.79	3.00
Diptera	.78	2.99	4.41	4.29	7.36	9.46	11.76	4.46	..
Other insects	18.77	3.21	9.10	6.56	4.92	4.44	1.14	4.59	10.00
Arachnida	2.71	2.05	3.59	2.63	2.38	1.74	4 34	4.05	39.25
Other animal matter	.28	..	.37	.25	0.06	..	..	x	..

In Nebraska, 4 Philadelphia Vireo stomachs averaged 11 locusts and 16 other insects each, while the Warbling Vireo, Red-eyed Vireo and White-eyed Vireo were each observed feeding upon insects, especially locusts.[309]

Stomachs of 2 Warbling Vireos (*Vireosylva gilva gilva*), 13 Red-eyed Vireos (*V. olivacea*) and 10 White-eyed Vireos

[306] Chapin, *U. S. Dept. Agric., Bull.* 1355, 1925.
[307] Wetmore, *U. S. Dept. Agric., Bull.* 326, 97, 1916. Bowdish, *Auk* XX, 193-195, 1903.
[308] Chapin, "Food Habits of the Vireos," *U. S. Dept. Agric., Bull.* 1355 2-3, 1925.
[309] Aughey, 1st Rept. *U. S. Entom. Com.*, 27-28, 1878.

(*Vireo griseus griseus*); insects, 91%; parasitic wasps, 2%; other Hymenoptera, 6%; May-flies, 4%; caterpillars, 15%; bugs, 17%; beetles, 28%; miscellaneous insects, 8%; spiders, 11%; mulberries and sassafras, 9%.[310] All species investigated up to 1902 have the bad habit of eating ladybirds, but much more than offset this by taking many pernicious species.[311]

Jamaican Vireo (*Vireosylva calidris calidris*); 84 stomachs, Porto Rico; animal matter, 42.18%; grasshoppers and other Orthoptera, 6.34%; Homoptera, 6.37%; Coleoptera, 6.43%, mostly destructive; caterpillars, 9.7%; Hymenoptera, 2.03%, ½ beneficial; Diptera, 0.21%; earwigs, 0.83%; spiders, 7.74%; tree toads, etc., 0.61%; vegetable matter, 57.82%, almost entirely wild fruits of no value.[312] On the Island of Carriacou it eats chiefly insects, but takes also berries.[313]

Red-eyed Vireo (*V. olivacea*); "noxious and destructive insects of numerous kinds constitute its principal food."[314] Warbling Vireo (*V. gilva gilva*); 3 stomachs from a canker-infested orchard; cankerworms, 44%; other caterpillars, 35%; Coleoptera, 15%.[315] Western Warbling Vireo (*V. g. swainsoni*); 110 stomachs; vegetable matter, 43% (82% in April); Hemiptera, 21%; ladybirds, 19%; other beetles, 7%, mostly harmful; Hymenoptera, 1%; flies, dragonflies and grasshoppers, 3%.[316]

Blue-headed Vireo (*Lanivireo solitarius solitarius*); 1 stomach; food ½ locusts, ½ other insects. Cassin Vireo (*L. s. cassini*); 46 stomachs; vegetable matter, 2%; Hemiptera, 5%; Lepidoptera, 23%, mostly caterpillars; ladybirds, 7%; other beetles, 3%; other insects, 3%; spiders, 4%.[317]

Hutton Vireo (*Vireo huttoni huttoni*); 54 stomachs; vegetable matter, 2%; Hemiptera, 49%; Lepidoptera, 22%, mostly

[310] Judd, *U. S. Biol. Surv., Bull.* 17, 102, 1902.
[311] Beal, *U. S. Biol. Surv., Bull.* 30, 38-39, 1907.
[312] Wetmore, *U. S. Dept. Agric., Bull.* 326, 97, 1916.
[313] Wells, *Auk*, XIX, 348, 1902.
[314] Barrows, *Michigan Bird Life*, 566, 1912.
[315] Forbes, *Bull. Ill. Lab. Nat. Hist.*, 1, No. 6, 10, 1883.
[316] Beal, *U. S. Biol. Surv., Bull.* 30, 39-40, 1907.
[317] Beal, *ibid.*, pp. 40-41.

caterpillars; ladybirds, 8%; other beetles, 3%; Hymenoptera, 7%; other insects, 5%; spiders, 2%.[318] Latimer Vireo (*V. latimeri*); 43 stomachs, Porto Rico; animal matter, 86.21%; mole crickets, 0.9%; grasshoppers, etc., 21.77%; true bugs, 15.1%; assassin bugs and stinkbugs, 3.67%; leaf beetles, 2.76%; longicorn beetles, 1.75%; snout beetles, 3.26%; miscellaneous beetles, 3.56%; caterpillars and moths, 21.88%; Diptera, 1.25%; Hymenoptera, 0.92%; spiders, 6.29%; miscellaneous animal matter, 3.1%; wild fruits, 13.79%, of no value.[319]

Family Coerebidæ. *Honey Creepers*

Porto Rican Honey Creeper (*Coereba portoricensis*); 149 stomachs, Porto Rico; vegetable matter, 2.44% (seeds and fiber); doubtless feeds largely on nectar, not recognized in the stomach contents; animal matter, 97.56%; lantern flies, 14.52%; leaf beetles, 2.11%; longicorn beetles, 0.35%; ladybirds, 19.87%; weevils, 3.89%; other Coleoptera, 2.89%; caterpillars, etc., 37.56%; flies, 1.26%; ants, 1.26%; other Hymenoptera, 4.65%; spiders, 25.89%; miscellaneous, 0.58%; ⅓ of animal food consists of beneficial insects and spiders.[320]

Family Mniotiltidæ. *Wood Warblers*

The Wood Warblers, or Warblers, as they are more briefly called in America, are highly insectivorous and very useful birds. Dr. Coues has paid just and eloquent tribute to them in a passage too long to be here quoted.[321] There are many species and they feed largely upon small tree insects that are overlooked by most birds and hard for man to deal with.[322] In California 94% of the food of the various species consists of insects; Western Yellow-throat, 97.77% insectivorous.[323]

[318] Beal, *Bull.* 30, *supra*, p. 41.
[319] Wetmore, *U. S. Dept. Agric., Bull.* 326, 95, 1916.
[320] Wetmore, *U. S. Dept. Agric., Bull.* 326, 109, 1916.
[321] Coues, *Birds of the Colorado Valley*, 201, 1878.
[322] Beal, Yearbook, *U. S. Dept. Agric. for* 1904, 254. See Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 270, 1889.
[323] Beal, Yearbook *U. S. Dept. Agric. for* 1908, 343-344.

In Maryland, 53 stomachs of 14 species; insects, etc., 83%; beetles, 21%, ⅔ injurious; ants, wasps and bees, 18%; Mayflies, 16%; caterpillars, 14%; bugs, 6%; miscellaneous insects, 8%; spiders, 11%; snails, 2%; fruit, 4%.[324] From a canker-infested orchard in Illinois, 15 stomachs of 7 species; canker-worms, 66%; undetermined caterpillars, 6%; boring beetles, 10%; miscellaneous insects, etc., 18%.[325] In May, 1900, the apple buds and blossoms in a certain district each contained numbers of plant lice when Warblers in multitudes reached the orchard in migration; after the birds passed through very few of the insects could be found, so thorough had the work been done by the birds.[326] Many Warblers distribute a few undigested seeds of poison ivy and other noxious plants.[327]

The following table is compiled from Beal's first report on birds in relation to the fruit industry of California: [328]

Number of stomachs	114	65	383	98	2	31	52
	Yellow-throat Geothlypis trichas 2 western subspecies	Orange-crowned Warbler Vermivora celata celata	Audubon Warbler Dendroica auduboni auduboni	Yellow Warblers Dendroica æstiva 2 subspecies	Myrtle Warbler Dendroica coronata	Townsend Warbler Dendroica townsendi	Golden Pileolated Warbler Wilsonia pusilla chrysæola
	Food percentages, omitting fractions						
Vegetable matter	..	9	15	2	..	5	7
Fruit	..	3	5	2	..	..	7
Seeds	..	x	9	..	..	x	..
Galls containing insect larvæ	..	x	..	..	..	x	..
Animal matter	99	91	84	97	..	95	93
Hemiptera, mostly harmful	28	25	20	19	Full	42	35
Coleoptera, chiefly harmful	15	19	6	16	..	20	9
Lepidoptera, mostly caterpillars	5	24	14	18	..	x	5
Hymenoptera, mostly small wasps and ants	35	15	26	30	..	25	31
Diptera	12	1	16	9	..	..	11
Miscellaneous insects	..	..	..	5	..	x	..
Spiders	4	7	..	..	..	x	1

[324] Beal, *U. S. Biol. Surv., Bull.* 17, 102-104, 1902.
[325] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 10, 1883.
[326] Beal, Yearbook *U. S. Dept. Agric. for* 1900, 298.
[327] Barrows, *Michigan Bird Life*, 589, 604, 618, 1912.
[328] Beal, *U. S. Biol. Surv., Bull.* 30, 1907.

The following table has been compiled from Aughey's report on the food of Nebraska birds, with special reference to locusts: [329]

	Number of stomachs	Locust eggs	Average number of locusts	Average number of other insects	Observed catching locusts	Observed catching other insects
Black-and-white Warbler. Mniotilta varia	1	..	41	12	x	..
Northern Parula Warbler. Compsothlypis americana pusilla	..	..	..	..	x	x
Prothonotary Warbler. Prothonotaria citrea	..	..	..	..	x	..
Worm-eating Warbler. Helmitheros vermivorus	..	..	..	..	x	..
Blue-winged Warbler. Vermivora pinus	..	..	..	..	x	..
Nashville Warbler. V. ruficapilla ruficapilla	1	..	21	x	x	..
Tennessee Warbler. V. peregrina	..	..	..	..	x	..
Yellow Warbler. Dendroica æstiva æstiva	7	..	11	25	..	..
Black-throated Green Warbler. D. virens	5	..	23	21	..	..
Black-throated Blue Warbler. D. cærulescens cærulescens	1	..	23	15	..	..
Cerulean Warbler. D. cerulea	..	..	..	..	x	..
Myrtle Warbler. D. coronata	1	..	31	5	..	..
Black-poll Warbler. D. striata	4	..	31	12	..	..
Bay-breasted Warbler. D. castanea	1	..	19	22	..	..
Chestnut-sided Warbler. D. pensylvanica	1	..	17	21	..	..
Magnolia Warbler. D. magnolia	1	..	23	17	..	.
Prairie Warbler. D. discolor	8	..	14	17	..	..
Yellow-throated Warbler. D. dominica dominica	1	x	15	24	..	..
Palm Warbler. D. palmarum palmarum	1	..	16	x	..	..
Pine Warbler. D. vigorsi	1	x	11	..	..	.
Oven-bird. Seiurus aurocapillus	6	x	18	15	..	..
Water-thrush. S. noveboracensis	1	x	19	30	..	..
Grinnell Water-thrush. S. n. notabilis	1	..	13	37	..	..
Kentucky Warbler. Oporornis formosus	1	..	9	x	..	..
Macgillivray Warbler. O. tolmiei	..	..	..	..	x	..
Maryland Yellowthroat. Geothlypis trichas trichas	1	..	8	..	x	..
Yellow-breasted Chat. Icteria virens virens	..	..	..	..	x	..
Hooded Warbler. Wilsonia citrina	..	..	..	..	x	..
Wilson Warbler. W. pusilla pusilla	..	..	..	..	x	..
Canada Warbler. W. canadensis	1	..	5	29	..	..
Redstart. Setophaga ruticilla	7	..	23	16	..	..

The table on the opposite page has been compiled from Wetmore's report on the Birds of Porto Rico.[330]

Tennessee Warbler (*Vermivora peregrina*); one of the few Warblers destructive to fruit, especially grapes; however, it feeds chiefly upon destructive insects.[331] One from a canker-infested orchard; cankerworms, 80%; beetles, 20%.[332]

Cape May Warbler (*Dendroica tigrina*); destructive to

[329] Aughey, 1st Rept. *U. S. Entom. Com.*, App. II, 1878.
[330] Wetmore, "Birds of Porto Rico," *U. S. Dept. Agric., Bull.* 326, 1916.
[331] Barrows, *Michigan Bird Life*, 589, 1912.
[332] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 9, 1883.

Number of stomachs	13	5	4	13	63	41	15	4	8	11	61
	Redstart Setophaga ruticilla	Louisiana Water-thrush S. motacilla	Water-thrush and Grinnell Water-thrush Seiurus n. noveboracensis, and S. n. notabilis	Ovenbird Seiurus aurocapillus	Porto Rican Warbler Dendroica petechia bartholemica	Adelaide Warbler Dendroica adelaidæ	Prairie Warbler Dendroica discolor	Myrtle Warbler Dendroica coronata	Black-throated Blue Warbler Dendroica cærulescens cærulescens	Black-and-White Warbler Mniotilta varia	Northern Parula Warbler Compsothlypis americana pusilla
	Food percentages										
Vegetable matter (seeds)	100	2		37.57					24.5		2.3
Animal matter	100	98		62.43	100	100	100		75.5	100	97.7
Euplexoptera (earwigs)					x					8.5	
Hemiptera	37.23				27.87	61.29	43.78	x	26.33	8.75	29.63
Coleoptera	4.61			14.43	14.62	14.28	16.	x	18.80	40.71	22.53
Lepidoptera	11.75				11.95	11.23	12.7	x	6.7	5.63	10.44
Hymenoptera	6.67		24	8.9	9.3	2.12	3.82		0.96	.56	3.64
Diptera	39.24	33	43		8.16	.45	.35	x	10.09		1.19
Orthoptera				2.17	7.21	2.61				27.06	
Miscellaneous insects		x	x								
Spiders				2.33	18.07	7.49	19.59	x	12.62	8.79	29.53
Snails		x		30.17							
Tree toads		x		.93							
Miscellaneous animal matter						.63	3.76				.36

grapes, sometimes puncturing 50% of the crop; 10 stomachs; Hymenoptera, 57.5%, ⅓ useful parasitic species, the balance ants and small bees; Diptera, 16.7%, many of them useful; small moths, 16.7%; beetles, 7.8%; remainder Hemiptera and other insects and spiders; grape juice not shown in analyses.[333] Yellow Warbler (*D. æstiva æstiva*); 5 stomachs from a canker-infested orchard; insects, 94%; spiders, 6%; canker-worms, 66%; Coleoptera, 23%; Hemiptera, 1%; Hymenoptera, 2%.[334] Of 25 Texas stomachs, 1 contained a cotton-boll weevil.[335] Seven Utah stomachs; 2 contained alfalfa weevils, forming 25% of the food in 1; in the others, caterpillars 70%.[336] Myrtle Warbler (*D. coronata*); fond of berries of wax-myrtle, hence its name. Insects 78% of total food, mostly minute; scale insects and plant lice an important item of diet; flies the largest item; also takes small wasps, beetles, weevils and ants; vegetable matter, 22%, consisting of fruit and seeds, especially poison ivy, pine and bayberry.[337] Seen eating broken oranges from beneath the tree.[338]

Audubon Warbler (*D. auduboni auduboni*); food in part small beetles, caterpillars, plant lice and ants; devours an "immense number" of ants.[339] One from New Mexico contained beetles and 1 wild bee.[340] Chestnut-sided Warbler (*D. pensylvanica*); 2 stomachs from a canker-infested orchard; cankerworms, 66%; other caterpillars, 10%; ants, 6%; Coleoptera, 11%; plant lice, 5%.[341] Black-poll Warbler (*D. striata*); 4 stomachs from a canker-infested orchard; cankerworms, 66%; boring beetles, 15%; other beetles, 4%; ants, 4%; gnats, 5%; Hemiptera, a trace.[342] Black-throated

[333] Burns, *Auk*, XXXII, 231-233, 1915. See also Roberts, *ibid.*, 233-234. Lane, *ibid.*, 498.
[334] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 9, 1883.
[335] Howell, *U. S. Biol. Surv., Bull.* 29, 21, 1907. For feeding of nestlings, see Bigglestone, *Wilson Bull.*, No. 83, Vol. XXV, 53-57, 1913.
[336] Kalmbach, *U. S. Dept. Agric.*, Bull. 107, 41, 1914.
[337] U. S. Dept. Agric., *Farmers' Bull.* 513, 12, 1913.
[338] Brewster, *Auk*, VI, 279, 1889.
[339] Beal, Yearbook *U. S. Dept. Agric. for* 1904, 254. See also Beal and McAtee, *Farmers' Bull.* 506, 32-33.
[340] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 38, 1901.
[341] Forbes, *Bull. Ill. State Lab. Nat. Hist*, I, No. 6, 9, 1883.
[342] Forbes, *ibid.*, pp. 9-10.

Green Warbler (*D. virens*); 1 stomach from a canker-infested orchard; cankerworms, 70%; beetles, 15%; Hemiptera, 5%; Hymenoptera, gnats, coleopterous larvæ and mites, 10%.[343] Palm Warbler (*D. palmarum palmarum*); one bird caught from 40 to 60 insects per minute for at least 4 hours, making a total of not less than 9,600 for the whole period.[344]

Yellow-breasted Chat (*Icteria virens virens*); 5 Texas stomachs; 1 contained a cotton-boll weevil.[345] Maryland Yellowthroat (*Geothlypis trichas trichas*); 3 stomachs from a canker-infested orchard; caterpillars 80%, half cankerworms; Coleoptera, 8%; Hemiptera, 5%; gnats, 4%; [346] one took 3,500 plant lice in 40 minutes or at a rate of 5,250 per hour.[347] Louisiana Water-thrush (*Seiurus motacilla*); seen catching and eating small fishes in New York.[348]

Family Motacillidæ. *Wagtails.*

Pipit (*Anthus rubescens*); 301 stomachs; animal matter, 84.69%; insects, 77.06%, over 64% injurious species; vegetable matter, 15.33%; grass seeds, 4.06%; weed seeds, 8.04%; waste grain, 1.72%; debris, 1.51%.[349] Of a number of stomachs from cotton districts, several contained 1 or more cotton-boll weevils each.[350] Three Nebraska stomachs averaged 47 locusts and 4 other insects each.[351] During a grain aphid outbreak the aphids constituted 70% of the food of Pipits.[352] Sprague Pipit (*A. spraguei*); 11 stomachs; 2 filled with seeds of spurge and goatweed; in 6, grasshoppers and crickets, 75%; remainder of food Hymenoptera, mostly ants, Coleoptera, Hemiptera, and caterpillars.[353]

[343] Forbes, *ibid.*, p. 10.
[344] Judd, *U. S. Biol. Surv., Bull.* 17, 104, 1902.
[345] Howell, *U. S. Biol. Surv., Bull.* 29, 21, 1907.
[346] Forbes, *Bull. Ill. State Lab. Nat. Hist*, I, No. 6, 10, 1883.
[347] Allen, *Cornell Reading Courses*, IV, No. 76, 1914.
[348] Hix, *Copeia*, No. 30, p. 31, 1916.
[349] Gabrielson, *U. S. Dept. Agric., Bull.* 1249, 27-32, 1924.
[350] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905. Howell, *ibid., Bull.* 25, 14, 1906; *Bull.* 29, 22-23, 1907.
[351] Aughey, 1st Rept. *U. S. Entom. Com.*, 19, 1878.
[352] McAtee, *U. S. Dept. Agric., Yearbook for* 1912, 297-404.
[353] Gabrielson, *Bull.* 1249, *supra*, 32.

Family Cinclidæ. *Dippers*

The Dippers, or Water Ouzels, are commonly supposed to live on small fish and in captivity seem to prefer fish to all other food, but Newstead found no fish remains in Dippers that had been feeding under natural conditions,[354] and it is probable that their food is largely composed of aquatic insects and other invertebrates. One was seen to catch and eat a fish about 2 inches long.[355] In Nebraska they have been observed catching locusts.[356]

Family Mimidæ. *Thrashers, Mockingbirds, Catbirds, etc.*

Sage Thrasher (*Oreoscoptes montanus*); 10 stomachs obtained during an alfalfa weevil outbreak in Utah; alfalfa weevils, 12.5%; beetles, 10%; vegetable food consisted of a few currants in 1.[357] Damages grape crop more than 25% locally in Yakima Valley, Washington.[358]

Mockingbird (*Mimus polyglottos polyglottos*); food about ½ fruit, including many cultivated varieties; partly offset by destruction of injurious insects, such as grasshoppers, chinch-bugs, weevils, etc.[359] Of 85 stomachs from cotton districts, 5 contained 1 cotton-boll weevil each.[360] Two Illinois stomachs; Orthoptera, 60%, besides bugs, spiders, ants, etc.; no fruit.[361] One pair seen eating locusts in Nebraska.[362]

Western Mockingbird (*M. p. leucopterus*); 52 stomachs, California; fruit, 50%; seeds, etc., 21%; 33 stomachs from Los Angeles; animal matter, 23%; beetles, 1%; Hymenoptera,

[355] Michael, *Auk*, XXIX, 98-99, 1922.
[354] McAtee, *Proc. Acad. Nat. Sci. Phila.*, LXIV, 323, 1912.
[356] Aughey, 1st Rept. *U. S. Entom. Com.*, 16, 1878.
[357] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 42, 1914.
[358] Kennedy, *Auk*, XXVIII, 225-228, 1911; XXIX, 224-226, 1912.
[359] U. S. Dept. Agric., *Farmers' Bull.* 513, 12, 1913. Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 270, 1889; Beal, *U. S. Biol. Surv., Bull.* 17, 104, 1902; *Bull.* 30, 52-53, 1907. Judd, Yearbook *U. S. Dept. Agric. for* 1895, 415-416.
[360] Howell, *U. S. Biol. Surv., Bull.* 29, 22, 1907; *Bull.* 25, 14, 1906. Bailey, *ibid., Bull.* 22, 16, 1905.
[361] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 3, 142, 1903.
[362] Aughey, 1st Rept. *U. S. Entom. Com.*, 15, 1878.

10%, largely ants; grasshoppers, 11%; caterpillars and spiders, 1%; fruit, 74%, partly wild, some poison oak; 1 nestling stomach; grasshoppers and crickets, 92%; wild fruit, 8%; does very little damage to fruit in California.[363] Damages fruit in New Mexico.[364] Jamaican Mockingbird (*M. p. orpheus*); 49 stomachs, Porto Rico; animal matter, 31.21%; mole crickets, 3.62%; other Orthoptera, 4.84%; Coleoptera, 3.68%, nearly all harmful; moths and caterpillars, 12.4%; Hymenoptera, 1.85%, mainly ants; spiders and mites, 1.11%; miscellaneous insects and mollusks, 3.8%; wild fruits, 68.78%, of no economic importance.[365]

Catbird (*Dumatella carolinensis*); 645 stomachs; insects, 44%; vegetable matter, 56%, ⅓ cultivated fruit, balance wild fruits, including poison ivy; "in most parts of the country it does far more good than harm." [366] In Maryland, 74 stomachs; fruit 59%, largely cultivated varieties, with some wild berries; invertebrates, 41%, chiefly insects.[367] Florida stomachs contained insects and seeds.[368] Fourteen from a canker-infested orchard; insects, 98%; myriapods, 2%; cankerworms, 15%; other caterpillars, 11%; Coleoptera, 56%; ants, 14%; 22 stomachs from various situations; caterpillars, 12%; Coleoptera, 23%; ants, 18%;[369] 70 Illinois stomachs; insects, 83% in May, 49% in June, 18% in July, 46% in August, 21% in September; average of beneficial elements in food, 41%; injurious, 15%; neutral, 44%; fruit in June, July and August, 60%.[370] Five from Nebraska averaged 30 locusts and 10 other insects each.[371] Food of nestlings; fruit, 4%; insects, 96%, largely injurious species.[372]

[363] Beal, *U S. Biol. Surv., Bull.* 30, 52-54, 1907.
[364] Cockerell, *New Mex. Agric. Exper. Sta., Bull.* 37, 53, footnote, 1901. [365] Wetmore, *U. S. Dept. Agric., Bull.* 326, 91, 1916.
[366] Beal, *Farmers' Bull.* 630, 7-8, 1915; *ibid., Bull.* 54, 33-34, 1898; Yearbook *U. S. Agric. Dept. for* 1900, 303-304. *Farmers' Bull.* 513, 11, 1913.
[367] Judd, *U. S. Biol. Surv., Bull.* 17, 104-105, 1902; Yearbook *U. S. Dept. Agric. for* 1895, 406-411.
[368] Baker, *Proc. Acad. Nat. Sci. Phila.*, XLI, 270, 1889.
[369] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 6-7, 1883.
[370] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 3, 115-117, 1903.
[371] Aughey, 1st Rept. *U. S. Entom. Com.*, 15, 1878.
[372] Gabrielson, *Wilson Bull.*, XXV, 175-176, 1913.

Brown Thrasher (*Toxostoma rufum*); 121 stomachs; vegetable matter, 35%; fruit, 8%, mostly cultivated; grain, 3%; animal matter, 63%; Coleoptera, 31%; Orthoptera, 12%; caterpillars, 12%; bugs, spiders and millipeds, 6%; takes some poison ivy; mineral matter, 2%.[373] Illinois, 64 stomachs, June, July and August; fruit, 38%; insects, about 50%; beneficial elements in food, 33%; harmful, 26%; neutral, 41%.[374] Four from a canker-infested orchard; myriapods, 6%; insects, 94%; cankerworms, 10%; other Lepidoptera, 10%; Coleoptera, 64%.[375] In 636 stomachs, insects and allies, 64%, half beetles, remainder grasshoppers, caterpillars, bugs and spiders; fruit, wild and cultivated, 3%.[376] Seen eating locusts in Nebraska.[377] Of 38 stomachs from cotton districts, only 1 contained a cotton-boll weevil.[378] Gabrielson has published a detailed account of the feeding of nestlings of this species.[379] California Thrasher (*T. redivivum*); 82 stomachs; vegetable matter, 59%; fruit, 18%; seeds of poison oak and other *Rhus*, 14%; miscellaneous vegetable matter, 26%; animal matter, 41%; predaceous beetles, 3.8%; other beetles, 6%; Hymenoptera, 12%, ½ ants; Lepidoptera, 8%; flies, 6%; spiders and myriapods, 6%.[380]

Pearly-eyed Thrasher (*Margarops fuscatus fuscatus*); 38 stomachs, Porto Rico; animal matter, 12.81%; Orthoptera 2.75%; weevils, 1.36%; spiders, 2.63%; crustaceans, a tree toad and 2 lizards, 1.45%; vegetable matter, 87.19%, mainly wild fruits, of no commercial value.[381]

[373] Judd, Yearbook *U. S. Dept. Agric. for* 1895, 411-415; *U. S. Biol. Surv., Bull.* 17, 105-106, 1902. Beal, *U. S. Biol. Surv., Bull.* 30, 55 1907.

[374] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 3, 127-137 1903.

[375] Forbes, *ibid.*, No. 6, 7, 1883.

[376] Beal, *Farmers' Bull.* 630, 7, 1914. *Farmers' Bull.* 513, 1 1913.

[377] Aughey, 1st Rept. *U. S. Entom. Com.*, 15, 1878.

[378] Howell, *U. S. Biol. Surv., Bull.* 29, 23, 1907; *Bull.* 25, 15, 190 Bailey, *Bull.* 22, 16, 1905.

[379] Gabrielson, *Wilson Bull.*, June, 1912, 65-94.

[380] Beal, *U. S. Biol. Surv., Bull.* 30, 56, 1907.

[381] Wetmore, *U. S. Dept. Agric., Bull.* 326, 89, 1916.

Family Troglodytidæ. *Wrens*

The Wrens are mostly highly insectivorous, the insects taken by them being chiefly noxious species, the vegetable portion of their food being insignificant.[382] In California, 95% of their food consists of insects.[383]

The following table is compiled from Beal's report on birds in relation to the fruit industry in California: [384]

Number of stomachs	53	36	146	41
	Western Marsh Wren Telmatodytes palustris plesius	Western House Wren Troglodytes aëdon parkmani	Bewick Wren Thyomanes bewicki bewicki	Cactus Wren Heleodytes brunneicapillus couesi
	Food percentages			
Vegetable matter	2	2	3	17
Fruit, mostly wild	..	..	..	13
Seeds	..	..	..	4
Animal matter	98	97	97	83
Hymenoptera	8	..	17	27
Coleoptera, mostly harmful species	16	20	21	27
Lepidoptera	17	24	12	5
Hemiptera	29	33	31	5
Orthoptera	x	5	4	15
Diptera	x	..	6	..
Odonata	x	..	..	..
Miscellaneous insects	11	15	..	x
Spiders	5	x	x	x
Snails	x	..	..	..

Aughey reports the following species as feeding their young with locusts in Nebraska: Rock Wren (*Salpinctes obsoletus obsoletus*), Carolina Wren (*Thyrothorus ludovicianus ludovicianus*), Bewick Wren (*Thyomanes bewicki bewicki*), House Wren (*Troglodytes aëdon aëdon*), Western House Wren (*T. a. parkmani*) and Long-billed Marsh Wren (*Telmatodytes palustris palustris*); also found 13 locusts in the stomach of one adult Winter Wren (*Nannus hiemalis hiemalis*).[385]

[382] Beal, *U. S. Biol. Surv., Bull.* 30, 57, 1907.
[383] Beal, Yearbook *U. S. Dept. Agric. for* 1898, 343.
[384] Beal, *U. S. Biol. Surv., Bull.* 30, 1907.
[385] Aughey, 1st Rept. *U. S. Entom. Com.*, 18, 1878.

Cactus Wren (*Heleodytes brunneicapillus couesi*); remains of a lizard in 1 and of a tree toad in another.[386] Rock Wren (*Salpinctus obsoletus obsoletus*) and Dotted Canyon Wren (*Catherpes mexicanus punctulatus*); food habits similar to those of other Wrens, as shown by examination of stomach contents.[387] Carolina Wren (*Thyrothorus ludovicianus ludovicianus*); 1 stomach; contained grasshoppers, caterpillars and beetles.[388] Of 17 from cotton districts, 6 contained 8 cotton-boll weevils.[389]

House Wren (*Troglodytes aëdon aëdon*); 88 stomachs; insects and allies, 98%, ½ grasshoppers and beetles, ½ caterpillars, bugs and spiders; vegetable debris, 2%.[390] Twenty Maryland stomachs; grasshoppers and crickets, 27%; moths, cutworms and allied larvæ, 19%; beetles, 11%; bugs, 9%; ants, 8%; Mayflies, 2%; miscellaneous insects, 2%; spiders, 21%; snails, 1%.[391] Stomachs from a canker-infested orchard; insects, 93%; cankerworms; 5%; other Lepidoptera, 59%; Diptera, 4%; ants, 5%; Hemiptera, 13%; Coleoptera, 10%; spiders, 6%; myriapods, 1%.[392] The feeding of the nestlings has been described in many publications.[393]

The year 1925 witnessed a vigorous discussion of the House Wren in some of the bird magazines. This small bird is possessed of a very pugnacious disposition, sometimes fighting even unto death, much given to driving other birds, even those larger than itself, from its nesting site, in this respect differing only in degree, not in kind, from some other birds. Its desire to maintain exclusive control of the territory surrounding its home is instinctive, and is shared not only by other

[386] Storer, *Condor*, XXII, 159, 1920.
[387] Beal, *U. S. Biol. Surv., Bull.* 30, 65-66, 1907.
[388] Judd, *U. S. Biol. Surv., Bull.* 30, 107, 1902.
[389] Bailey, *U. S. Biol. Surv., Bull.* 22, 16, 1905. Howell, *U. S. Biol. Surv., Bull.* 25, 14, 1906; *Bull.* 29, 22, 1907.
[390] Beal, *Farmers' Bull.* 630, 6, 1915. Judd, Yearbook *U. S. Dept. Agric. for* 1895, 416-418. *Farmers' Bull.* 513, 10, 1913. Oldys, Yearbook *U. S. Dept. Agric. for* 1902, 216.
[391] Judd, *U. S. Biol. Surv., Bull.* 17, 107, 1902.
[392] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 8-9, 1883.
[393] See, for example, Allen, *Condor*, XXIII, 166, 1921. Prescott, *Bird-Lore*, XVIII, 360-361, 1916.

birds, but by some fishes and mammals. This instinct, when the resulting warfare is directed against other species that come into close competition in the matter of food, is of distinct value to the species possessing it. Coupled with this trait, in case of the House Wren, is a propensity for destroying the eggs of other birds nesting in its vicinity. This, also, is shared by some other birds. It is probable that under perfectly normal conditions these bad habits of the Wren do little damage, which is evidenced by the fact that many other species of birds have continued to exist in large numbers within the breeding range of the Wren, and the Wren has not in most localities unduly increased in numbers. It is not unlikely that in some localities the encouragement of the House Wren by the erection of too many nesting boxes adapted especially to its needs and not convenient for the use of most other birds may have caused its increase to such an extent as to make it a menace to other bird life, in which case the remedy is obvious. A bird so useful because of its food habits and so desirable for esthetic reasons, should not be subjected to general persecution because it is harmful in some localities, nor should it be destroyed simply because it does drive away some other birds or destroy their eggs. If we are to annihilate every species of bird that in the sharp competition for food and nesting sites—for suitable environment in which to rear their young—attack other species, we shall have few species left to carry on their work so necessary to the welfare of the human race. A great many useful species do more or less damage to other useful species. Nature has its cruel, as well as its beneficent phases, and the two are so interwoven that it is impossible to unscramble them.[394]

[394] See especially, for the prosecution: Sherman, *Bird-Lore*, XXVII, 97-100, 1925; *Wilson Bull.*, XXXVII, 129-132, 1925; Weigle, *Bird-Lore*, XXVII, 170, 239-241, 1925; *Wilson Bull.*, XXXVII, 160-163, 1925; Swanson, *Bird-Lore*, XXVII, 243-244, 1925; Creaser, *Bird-Lore*, XXVII, 163-167, 1925; Reed, *Bird-Lore*, XXVII, 168-169, 1925; Brooks, *Bird-Lore*, XXVII, 237-239, 1925; *Condor*, XXVIII, 93, 1926. For the defense: Bryens, *Wilson Bull.*, XXXVII, 157-159, 1925; Baldwin, *Bird-Lore*, XXVII, 234-237, 1925; Lehman, *Bird-Lore*, XXVII, 245, 1925; Watt, *Bird-Lore*, XXVII, 171, 1925; Chapman, *Bird-Lore*, XXVII, 203, 1925.

Long-billed Marsh Wren (*Telmatodytes palustris palustris*); 5 stomachs; contained insects and spiders; mostly spiders and beetles; minor part Hemiptera, Diptera and Hymenoptera.[395]

Family Certhiidæ. *Creepers*

Brown Creeper (*Certhia familiaris americana*); food consists of minute insects and insect eggs, cocoons, etc.[396] One stomach contained beetles, sawflies, flying ants, spiders and pine seeds.[397] A pair were observed to carry 27 distinguishable locusts to their young in 1 hour.[398] California Creeper (*C. f. occidentalis*); of 7 stomachs, only 1 contained any vegetable matter (seeds, 19%); food consisted of small beetles (including many weevils), wasps, ants, bugs and a few spiders.[399]

Family Sittidæ. *Nuthatches*

Feed largely on small, harmful insects and their eggs and larvæ; take also galls, seeds and wild fruits.[400] White-breasted Nuthatch (*Sitta carolinensis carolinensis*); 34 stomachs; in winter, insects, 25.7%; seeds, 67.4%; in spring, insects, 79.5%; seeds, 13.5%.[401] Food for the year, 50% insects and spiders, mostly harmful species; grain, 10%, chiefly waste; vegetable food over ½ acorns and other nuts and large seeds.[402] Slender-billed Nuthatch (*S. c. aculeata*); food substantially same as that of Pygmy Nuthatch.[403] Four Nebraska stomachs averaged 23 locusts, 4 other insects and 4 seeds each.[404]

Red-breasted Nuthatch (*S. canadensis*); food like that of

[395] Judd, *U. S. Biol. Surv., Bull.* 17, 107, 1902.
[396] U. S. Dept. Agric., *Farmers' Bull.* 513, 10, 1913. Beal, Yearbook *U. S. Dept. Agric. for* 1900, 296.
[397] Judd, *U. S. Biol. Surv., Bull.* 17, 107, 1902.
[398] Aughey, 1st Rept. *U. S. Entom. Com.*, 17, 1878.
[399] Beal, *U. S. Biol. Surv., Bull.* 30, 66, 1907.
[400] Beal, *U. S. Biol. Surv., Bull.* 30, 66-67, 1907.
[401] Sanderson, *Auk*, XV, 144-145, 1898. Barrows, *Michigan Bird Life*, 687-692. Judd, *U. S. Biol. Surv., Bull.* 17, 107, 1902.
[402] *Farmers' Bull.* 513, 9, 1913.
[403] Beal, *U. S. Biol. Surv., Bull.* 30, 68, 1907.
[404] Aughey, 1st Rept. *U. S. Entom. Com.*, 17, 1878.

the Pygmy Nuthatch.[405] Seen twice eating locusts in Nebraska.[406] Found feeding extensively on spruce seeds in October; 1 stomach contained 3 seeds.[407] Pygmy Nuthatch (*S. pygmæa pygmæa*); 31 stomachs; seeds, 17%, largely coniferous; animal matter, 83%; Hymenoptera, 38%, mostly wasps, a few ants; Hemiptera, 23%, largely spittle insects; Coleoptera, 12%, chiefly weevils, with some useful beetles; caterpillars, 8%; spiders, 1%.[408]

Family PARIDÆ. *Titmice, Chickadees*

Tufted Titmouse (*Bæolophus bicolor*); 1 Maryland stomach; several blueberries, a beetle and a cutworm.[409] One from Texas contained a cotton-boll weevil.[410] Four from Nebraska averaged 65 locusts, 4 other insects and a few seeds.[411] Black-crested Titmouse (*B. inornatus inornatus*); 76 stomachs; vegetable matter, 57%; fruit, 32%; grain, 1.5%; weed seeds, galls and rubbish, 24%; animal matter, 43%; Hemiptera, 12% (black olive scale, 5% for the season, 34% in August); Lepidoptera, 11%, mostly caterpillars; Coleoptera, 7%, all harmful species; ants, 4%; wasps, 6%; other insects, 5%; spiders, 1%.[412] Seen feeding on locusts and other insects in Nebraska[413] and on sunflower seeds in California.[414]

Chickadee (*Penthestes atricapillus atricapillus*); 70% of food insects; seeds, 30%, largely of conifers, a few poison ivy and some weed seeds.[415] In 289 stomachs, caterpillars, moths and their eggs, 68%; wild fruit, 32%.[416] Two stomachs from

[405] Beal, *Bull.* 30, 68.
[406] Aughey, *1st Rept.* 17.
[407] Averill, *Auk*, V, 118, 1888.
[408] Beal, *Bull.* 30, 67-68.
[409] Judd, *U. S. Biol. Surv., Bull.* 17, 107, 1902.
[410] Howell, *U. S. Biol. Surv., Bull.* 29, 22, 1907.
[411] Aughey, 1st Rept. *U. S. Entom. Com.*, 16, 1878.
[412] Beal, *U. S. Biol. Surv., Bull.* 30, 70, 1907; Yearbook *U. S. Dept. Agric. for* 1904, 253.
[413] Aughey, *1st Rept.*, 16.
[414] Jordan, *Condor*, XXVII, 241, 1925.
[415] U. S. Dept. Agric., *Farmers' Bull.* 513, 9, 1913. Barrows, *Michigan Bird Life*, 695-696, 1912.
[416] Beal, *Farmers' Bull.* 630, 5-6, 1915.

a canker-infested orchard; cankerworms, 61%; Coleoptera, 39%.[417] Between 200 and 300 cankerworms in 1 stomach; 450 plant-louse eggs in another.[418] In 28 stomachs, winter food, 39% vegetable matter; no seeds; in spring, wholly insectivorous.[419] Winter food, ¼ vegetable matter, mostly buds taken with plant lice; insects, 50%; eggs of plant lice, 20%; spiders and their eggs; over 450 plant-louse eggs taken by 1 bird in 1 day; 10 birds probably take over 100,000 eggs during a winter.[420] Long-tailed Chickadee (*P. a. septentrionalis*); 9 Nebraska stomachs averaged 53 locusts and 6 other insects each.[421] Of 6 Utah stomachs, 3 contained alfalfa weevils; most of the food unrecognizable but included large numbers of plant lice.[422]

Carolina Chickadee (*P. carolinensis carolinensis*); 7 stomachs; all contained insects and insect eggs; 4 contained seeds of mulberry, pine and ragweed.[423] Mountain Chickadee (*P. gambeli gambeli*); food much the same as that of other Chickadees.[424] Chestnut-sided Chickadee (*P. rufescens*, subspecies); 57 stomachs; fruit, 8%; seeds, 20%; miscellaneous vegetable matter, 7%; caterpillars, 18% (53% in August); Hemiptera, 25%; wasps, 13%; beetles, 2%; spiders, 7% (16% in August).[425]

Bush-tit and California Bush-tit (*Psaltriparus minimus minimus, P. m. californicus*); feed largely on plant lice and scale insects; special foes of the black olive scale in California.[426] In 253 stomachs from California, fruit, 1%; seeds of poison oak, galls and rubbish, 18%; Hemiptera, 44% (scale insects, 19%); beetles, 10%, mostly harmful species; Lepi-

[417] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 6, 8, 1883.
[418] Judd, *U. S. Biol. Surv., Bull.* 17, 108, 1902.
[419] Sanderson, *Auk*, XV, 144-155, 1898.
[420] Weed, *N. Hamp. Agric. Exper. Sta., Bull.* 54. Beal, Yearbook *U. S. Dept. Agric. for* 1900, 296.
[421] Aughey, 1st Rept. *U. S. Entom. Com.*, 17, 1878.
[422] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 42-43, 1914.
[423] Judd, *U. S. Biol. Surv., Bull.* 17, 107-108, 1902.
[424] Beal, *U. S. Biol. Surv., Bull.* 30, 71, 1907.
[425] Beal, *ibid.*, pp. 70-71.
[426] Beal, Yearbook, *U. S. Dept. Agric. for* 1900, 296; Yearbook for 1904, 253.

doptera, 16%; Hymenoptera, 1.5%; miscellaneous insects and spiders, 8%.[427] In 66 stomachs, insects, 83%, mostly injurious.[428]

Blue Titmouse (*Parus caeruleus*); 3 in Switzerland ate from 8,000 to 9,000 insects daily; in raising their family a pair will destroy 24,000,000 insects in a year.[429] Often damages fruit.[430] Great Titmouse (*P. major*), Europe; attacks other birds and damages fruit.[431]

Family Chamæidæ. *Wren-tits*

Wren-tits (*Chamæa fasciata,* subspecies); 165 stomachs; fruit, 20%; poison oak seeds, 16%; weed seeds, galls and rubbish, 11%; Hymenoptera, 23%, ½ ants, ½ wasps; beetles, 10% (9% harmful species); Hemiptera, 7%; miscellaneous insects, 3%; spiders, 2%.[432]

Family Sylviidæ. *Warblers, Kinglets and Gnatcatchers*

Kinglets are "useful insectivorous midgets."[433] Food mostly small tree insects, such as plant lice and scale insects, with weevils, insect eggs, etc.[434] Golden-crowned Kinglet (*Regulus satrapa satrapa*); 9 stomachs; no vegetable matter; insect food as usual with closely related species.[435] Seen feeding on locusts in Nebraska.[436] Ruby-crowned Kinglet (*R. calendula calendula*); 294 stomachs; fruit, 1%; poison oak and leaf galls, 4%; animal matter, 94% (100% in November, 70% in January); Hymenoptera, 32%; Hemiptera, 26%; beetles, 13% (11% harmful species); Lepidoptera, 3%; Diptera,

[427] Beal, *U. S. Biol. Surv., Bull.* 30, 74-80, 1907.
[428] Beal, *U. S. Dept. Agric., Bull.* 630, 5-6, 1915.
[429] Hewitt, *Ottawa Naturalist,* XXVII, 164, 1914.
[430] Taylor, *Proc. Brit. Col. Entom. Soc.,* 1913, 39-40.
[431] Palmer, Yearbook *U. S. Dept. Agric. for* 1898, 104-105.
[432] Beal. *U. S. Biol. Surv., Bull.* 30, 71-74, 1907.
[433] Judd, *U. S. Biol. Surv., Bull.* 17, 108, 1902.
[434] Beal, Yearbook *U. S. Dept. Agric. for* 1904, 254.
[435] Beal, *U. S. Biol. Surv., Bull.* 30, 84, 1907.
[436] Aughey, 1st Rept. *U. S. Entom. Com.,* 16, 1878.

17%; spiders, etc., 2%.[437] One Nebraska stomach contained 29 locusts, with other insects.[438]

Blue-gray Gnatcatcher (*Polioptila cærulea cærulea*); 3 stomachs; contained beetles, jointworms, flies, caddisflies, etc.[439] Twice seen feeding on locusts in Nebraska.[440] Western and California Gnatcatchers (*P. c. obscura, P. californica*); 60 stomachs, 30 of each; contents similar; 1 contained *Rhus* seeds, 92%; 3 contained a little vegetable matter; of the total food of all, Hemiptera, 64%, all harmful species; wasps and ants, 16%; beetles, 7%, mostly harmful; caterpillars, 5%; other insects and spiders, 6%.[441]

Family Turdidæ. *Thrushes, Solitaires, American Robins, Bluebirds, etc.*

The following table has been compiled from Aughey's report on the food of Nebraska birds: [442]

	Number of stomachs	Average number of locusts	Seen eating locusts	Average number of other insects	Average number of seeds
Robin. Planesticus migratorius migratorius . . .	6	45	..	14	2
Wood Thrush. Hylocichla mustelina	3	22	..	4	..
Hermit Thrush. Hylocichla guttata pallasi . . .	1	19	..	16	..
Olive-backed Thrush. Hylocichla ustulata swainsoni	2	27	..	12	..
Veery. Hylocichla fuscescens fuscescens	2	36	..	29	..
Bluebird. Sialia sialis sialis	3	22	..	6	..
Mountain Bluebird. Sialia currucoides	..	..	x	..	..
Townsend Solitaire. Myadestes townsendi . . .	..	..	x	..	..

The following table has been compiled from Beal's minutely detailed reports on the food of various members of this family: [443]

[437] Beal, *U. S. Biol. Surv., Bull.* 30, 81-85, 1907. Beal and McAtee, *Farmers' Bull.* 506, 34-35, 1912. Farmers' Bull. 513, 8, 1913.
[438] Aughey, 1st Rept. *U. S. Entom. Com.*, 16, 1878.
[439] Judd, *U. S. Biol. Surv., Bull.* 17, 108, 1902.
[440] Aughey, 1st Rept., *supra*, 16.
[441] Beal, *U. S. Biol. Surv., Bull.* 30, 84-86, 1907.
[442] Aughey, 1st Rept. *U. S. Entom. Com.*, 1878.
[443] Beal, "Food of Robins and Bluebirds of the United States," *U. S. Dept. Agric., Bull.* 171, 1915; "Food Habits of the Thrushes of the United States," *ibid., Bull.* 280, 1915.

Number of stomachs	41	171	178	111	463	551	1236	53	855	217	66
Food percentages, fractions omitted	Townsend Solitaire Myadestes townsendi	Wood Thrush Hylocichla mustellina	Veery and Willow Thrush Hylocichla fuscescens and H. f. salicicola	Gray-cheeked and Bicknell Thrushes Hylocichla aliciæ aliciæ and H. a. bicknelli	Olive-backed and Russet-backed Thrushes Hylocichla ustulata ustulata and H. u. swainsoni	Hermit Thrushes Hylocichla guttata, various subspecies	Robins Planesticus migratorius, several subspecies	Varied Thrushes Ixoreus nævius, 2 subspecies	Eastern Bluebird Sialia sialis sialis	Western Bluebirds Sialia mexicana, various subspecies	Mountain Bluebird Sialia currucoides
Animal matter	35	59	57	74	63	64	42	25	68	81	91
Coleoptera	10	20	14	33	16	15	16	4	20	24	30
Carabidæ, Cicindelidæ, Coccinellidæ	5	2	x	2	3	2	5	1	9	8	10
Scarabidæ	2	10	: :	x	: :	3	5	: :	5	: :	: :
Lampyridæ	: :	2	: :	: :	: :	: :	x	: :	: :	: :	: :
Weevils	: :	: :	2	x	5	3	2	: :	1	: :	8
Elateridæ	: :	: 2	: :	x	: :	: :	: :	: :	: :	: :	: :
Hymenoptera	5	11	13	21	21	17	: 2	6	5	6	16
Ants	4	8	10	16	15	12	1	4	3	5	12
Wasps and bees, largely wild	x	3	3	5	6	5	1	2	1	1	3
Hemiptera	3	1	x	x	11	3	2	1	2	6	3
Stinkbugs	: :	: :	: :	: :	x	x	x	: :	x	: :	x
Chinchbugs	: :	: :	: :	: :	: :	: :	x	: :	x	: :	: :
Scale insects	: :	: 2	: :	: :	x	: :	: :	: :	: :	x	: :
Diptera	x	2	x	x	6	3	: :	1	: :	x	x
Lepidoptera, chiefly caterpillars	12	9	11	8	10	9	3	2	x	20	14
Orthoptera	x	2	4	1	2	6	9	2	10	21	23
Miscellaneous insects	x	x	x	2	x	x	x	1	x	x	x
Spiders	2	x	6	5	x	x	1	3	1	1	x
Myriapods	: :	x	: :	: :	x	x	1	x	1	x	x
Worms	: :	x	: :	: :	x	x	x	x	x	x	x
Snails, crustaceans	: :	x	2	x	10	x	x	x	x	x	14
Lizards, tree toads	: :	: :	: :	: :	2	: :	: :	: :	x	: :	23
Miscellaneous animal matter	: :	: :	: :	: :	: :	: :	x	: :	: :	: :	: :
Vegetable matter	64	40	42	25	36	35	57	75	32	18	8
Fruit, undifferentiated	: :	: :	: :	: :	: :	: :	: :	: :	: :	14	x
Wild fruit	58	33	23	23	19	26	: :	23	21	: :	: :
Cultivated fruit	: :	3	12	x	12	1	x	3	x	x	: :
Mast	: :	: :	: :	: :	: :	: :	x	18	: :	: :	: :
Weed seeds	x	x	7	: :	x	x	x	9	x	1	x
* Poison ivy and oak	x	: :	: :	: :	: :	: :	x	x	x	2	x
Grain, mostly waste	: :	: :	: :	: :	: :	: :	x	: :	x	: :	: :
Miscellaneous vegetable matter	x	x	x	: :	x	x	: :	18	7	x	x

* The poison ivy and oak seeds not destroyed in eating them.

Townsend Solitaire (*Myadestes townsendi*); observed eating cedar berries in New Mexico.[444] In autumn, in New Mexico, food mostly pine seeds, cedar berries and a few insects.[445] In summer, feeds almost entirely on insects, catching them on the wing, hence has sometimes been called the Fly-catching Thrush.[446]

Wood Thrush (*Hylocichla mustelina*); 22 stomachs, Illinois; food chiefly insects, Coleoptera largely predominating; ants, Lepidoptera and Diptera next, in approximately equal proportions; Orthoptera and Hemiptera next; myriapods, 12%; fruit, 20%.[447] Gray-checked Thrush (*Hylocichla aliciæ aliciæ*); 3 Maryland stomachs; sawfly larvæ, ants, caterpillars, Mayflies, beetles, etc.[448] Ten Illinois stomachs; insects, 93%; ants, 43%; caterpillars, 15%; craneflies and larvæ, 9%; Coleoptera, 18%, only 1% useful species; grasshoppers, 3%; myriapods, 2%; snails, 5%.[449]

Russet-backed Thrush (*H. ustulata ustulata*); 157 stomachs, California; vegetable matter, 48%, mostly taken by adults only during the nesting season, while feeding their young on insects; a few seeds; animal matter, 52%; Coleoptera, 14% (3% useful species); ants, 16%; other Hymenoptera, Hemiptera, Diptera, Orthoptera and spiders, 12%; salamander bones in 1.[450] Olive-backed Thrush (*H. u. swainsoni*); 6 stomachs, Illinois; April and May, food similar to that of the Russet-backed Thrush; September, fruit, 60%, largely wild, ½ wild grapes; Hymenoptera, 19% (ants, 7%); caterpillars, 12%; Coleoptera, 18% (Carabidæ, 3%; leaf chafers, 3%; curculios, 2%); Hemiptera, 2%.[451] Two Maryland stomachs; ants, wasps, beetles and spiders.[452]

[444] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 41, 1901.
[445] Coues, *Birds of the Colorado Valley*, 46, 1878.
[446] Coues, *Birds of the Northwest*, 95, 1874.
[447] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 3, 137-139, 1903.
[448] Judd, *U. S. Biol. Surv., Bull.* 17, 108, 1902.
[449] Forbes, *Bull. Ill. Lab., supra*, 140-141.
[450] Beal, *U. S. Biol. Surv., Bull.* 30, 86-92, 1907; Yearbook *U. S. Dept. Agric. for* 1904, 251. *Farmers' Bull.* 513, 8, 1913.
[451] Forbes, *Bull. Ill. Lab., supra*, 141-142.
[452] Judd, *U. S. Biol. Surv., Bull.* 17, 108, 1902.

Alaska and other Hermit Thrushes (*H. guttata*, subspecies); 68 stomachs, California; vegetable matter, 44%; wild and waste fruit, 29%; seeds, 14%, including poison oak; animal matter, 56%; Hymenoptera, 24%, mostly ants; caterpillars, 10%; harmful Coleoptera, 11%, ⅔ weevils, a few useful species; other insects and spiders, 12%; salamander bones in 1.[453] Hermit Thrush (*H. g. pallasi*); 21 stomachs, Illinois; insects, 84%; ants, 15%; Lepidoptera, 19%; Diptera, 3%; Coleoptera, 30% (Carabidæ, 11%); grasshoppers, 7%[454]

Porto Rican Thrush (*Mimocichla ardosiacea portoricensis*); 42 stomachs, Porto Rico; animal matter, 36.54%; mole crickets, 0.86%; other Orthoptera, 0.36%; beetles, 3.86%; cutworms and other caterpillars, 12.25%; ants, 0.93%; bugs, 2.64%; earwigs and myriapods, 4.61%; snails, 2.62%; lizards and tree toads, 8.41%; vegetable matter, 63.46%, mostly wild fruits of no commercial value.[455] Black Thrush or European "Blackbird" (*Turdus merula merula*); introduced into New Zealand, where it damages small fruits.[456]

Robins, where overabundant and where fruit is scarce, especially cherries, sometimes destroy much fruit, but they prefer wild fruit, as do most fruit-eating birds. They do very little damage to the large fruit-growers, as a rule, because their numbers are too small in comparison with the total quantity of fruit in the orchards, and such as they take during the short fruit season is well paid for by the good they do during the balance of the year; but the single tree of the small owner may suffer greatly when not surrounded by other fruit trees to share the burden of the depredations. The planting of wild fruits about the orchards has been strongly urged, as this helps keep the birds from the cultivated varieties, yet retains their services in the destruction of insects and other pests.[456a]

[453] Beal, *U. S. Biol. Surv., Bull.* 30, 92-93, 1907.
[454] Forbes, *Bull. Ill. Lab., supra*, 139-140.
[455] Wetmore, *U. S. Dept. Agric., Bull.* 326, 92, 1916.
[456] Palmer, Yearbook *U. S. Dept. Agric. for* 1898, 106.
[456a] McAtee, "Plants Useful to Attract Birds and Protect Fruit," *Yearbook U. S. Dept. Agric. for* 1909, pp. 185-196. Forbush, "Food Plants to Attract Birds and Protect Fruit," Mass. State Board Agric., *Eco-*

Robin (eastern form, *Planesticus migratorius migratorius*); 114 Illinois stomachs examined by Forbes; food almost entirely insects from February to May inclusive; after May, 64% fruit, wild and cultivated; for the year, useful insects, 36%; injurious insects, 43%; neutral insects, 21%. The following table has been compiled from Forbes' reports: [457]

Number of stomachs	11	9	17	15	13	14	20	12	3
Months	Feb.	Mch.	April	May	June	July	Aug.	Sept.	Oct. and Dec.
	Food percentages								
Total insects	99	80	..	93	42	20	43	22	43
Hemiptera	..	..	3	x	..	..	..	..	..
Diptera	76	37	8	7	1	..	..	..	..
Total undifferentiated caterpillars	14	30	25	..	17	..	17	5	6
Cutworms	x	20	..	..	7	..	..	..	..
Cankerworms	..	..	..	28	..	..	..	..	..
Coleoptera	x	..	..	43	21	..	7	..	2
Orthoptera	x	..	5	..	..	..	10	2	..
Total Hymenoptera (ants)	..	..	..	1	..	..	..	15	35
Spiders	1	..	1	..	..	1	..	..	..
Myriapods	..	..	..	5	..	..	..	..	..
Earthworms	..	..	x	x	..	..	..	..	..
Undifferentiated fruit	..	..	x	..	55	79	56	70	..
Wild fruit	..	..	..	..	..	..	x	..	..
Wild grapes	..	..	..	..	..	..	..	..	53
Grapes	..	..	..	..	..	..	..	52	..
Raspberries	..	..	..	..	8	..	..	..	..
Cherries	..	..	..	..	47	..	..	..	..
Apples	..	..	..	..	..	..	..	..	x

In stomachs from a canker-infested orchard, caterpillars, 54%; from elsewhere, caterpillars, 23%.[458] In 330 stomachs, animal matter, 42%; beetles, 19%, ⅓ useful; grasshoppers, 10% (30% in August); caterpillars, 6%; vegetable matter, 58% (wild fruits, 47%; cultivated fruits in June and July, 25%).[459] At Marshall Hall, Maryland, the fruit item was wild berries, in 11 stomachs that contained many harmful

nomic Biology, Circular Number 49, 1916. Edson, "Fruits for Birds," *Bird-Lore*, XVII, 448-449, 1918. Beal, "A List of Trees, Shrubs, Vines and Herbaceous Plants Native to New England Bearing Fruit or Seeds Attractive to Birds," *Bird-Lore*, XIV, 201-203, 1912.

[457] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, I, No. 3, 1903; No. 6, 1883.

[458] Forbes, *ibid.*, No. 6, 18-19.

[459] Beal, *Farmers' Bull.* 54, 38, 1898.

[460] Judd, *U. S. Biol. Surv., Bull.* 17, 108-109, 1902.

insects.[460] Some stomachs examined in 1858, taken in March and April, contained only insects, 90% being cranefly larvæ.[461] In 1200 stomachs, vegetable matter, 58%, of which 51% was fruit, 5% of it wild.[462] Detected feeding young on somewhat hairy caterpillars.[463] Robins have been known to kill small snakes.[464]

Western Robin (*P. m. propinqua*); 71 stomachs, California; vegetable matter, 60%, mostly fruit, largely wild and waste; has damaged olive crop when usual food was scarce; animal matter, 40%; beetles, 13% (54% in April; weevils, 25% in April); caterpillars, 4%; miscellaneous insects and a few earthworms, 23%.[465] From Utah, 41 April stomachs; alfalfa weevils, 14%; caterpillars, 23.24%, many cutworms; click beetles and wireworms, 11.1%; flies, 5.97%; earthworms, 8.68%; rubbish, 12%; grain, 2.1%; 4 May stomachs; alfalfa weevils, 7.25%; 17 June stomachs; alfalfa weevils, 23.77%; caterpillars, 20%; rubbish, 25%; 18 July stomachs; alfalfa weevils, 9.39%; caterpillars, 37.72%; earthworms, 20%; rubbish, 25%.[466] One California stomach; 192 cutworms.[467] Seen eating cedar berries in New Mexico,[468] and I have found them in the mountains of Colorado during severe winter weather, fat and filled with cedar berries.

Bluebird (*Sialia sialis sialis*); 205 stomachs; insects and allies, 76%; beetles, 28% (8% useful); grasshoppers, 22% (60% in August and September); caterpillars, 11%.[469] In 655 stomachs, insects, 68%; beetles, 21% (9% useful); grasshoppers, 22%; caterpillars, 10%; spiders and myriapods, 6%; vegetable matter, 32%, mostly in winter, partly wild fruit.[470]

[461] Palmer, Yearbook, *U. S. Dept. Agric. for* 1898, 261, quoting Jenks.
[462] U. S. Dept. Agric., *Farmers' Bull.* 513, 7, 1913. See also Beal, Yearbook *U. S. Dept. for* 1900, 303; *Farmers' Bull.* 630, 3, 1915.
[463] Perrior, *Auk*, XVI, 284, 1899. Miller, *ibid.*, 362.
[464] Simpson, *Oologist*, XXIX, 402, 1912. Marshall, *Bird-Lore*, XXIII, 304, 1921.
[465] Beal, *U. S. Biol. Surv., Bull.* 30, 93-97, 1907; Yearbook *U. S. Dept. Agric. for* 1904, 252-253.
[466] Kalmbach, *U. S. Dept. Agric., Bull.* 107, 43-45, 1914.
[467] Bryant, *Condor*, XV, 93, 1913.
[468] Cockerell, *N. Mex. Agric. Exper. Sta., Bull.* 37, 41, 1901.
[469] Beal, *Farmers' Bull.* 54, 39, 1898.
[470] Beal, *Farmers' Bull.* 630, 2-3, 1915. *Farmers' Bull.* 513, 7, 1913.

Five stomachs from a canker-infested orchard, May; spiders, 2%; insects, 98%; cankerworms, 12%; other Lepidoptera, 5%; Coleoptera, 66% (Carabidæ, 23%; vine leaf chafers, 36%; Chrysomelidæ, 5%); Hemiptera, 15%.[471] In 108 stomachs from Illinois, every month except January and November; Lepidoptera, 26% (⅔ Noctuidæ); leaf chafers, 3%; Orthoptera, 21%; Ichneumons, 3%; Carabidæ, 7%; soldier bugs, 3%; ants, 4%; spiders, 8%; vegetable matter, 13%.[472] Seven Maryland stomachs, November and February; ½ of food bittersweet, woodbine, sumac and poison ivy seeds; all contained insects.[473]

Western Bluebird (*S. mexicanus occidentalis*); 187 stomachs, California; animal matter, 82%; predaceous beetles, 12%; other beetles, 17%, all harmful; caterpillars, 17%; grasshoppers and crickets, 24%; Hymenoptera, 0.4%; other insects, 10%; spiders, 2%; vegetable matter, 18%, mostly fruit, largely elderberries.[474] In 217 stomachs, insects and spiders, 82%; caterpillars, 20%; weed seeds and small fruits, 18%.[475] Seen eating cedar berries in winter in New Mexico.[476]

Mountain Bluebird (*S. corrucoides*); 14 stomachs, California; food closely resembles that of the Western Bluebird.[477] Seven Utah stomachs, April; alfalfa weevils, 4%; caterpillars, 32.5%; ground beetles, 31.3%; 9 July stomachs; alfalfa weevils, 11%; balance largely small cicadas.[478]

[471] Forbes, *Bull. Ill. State Lab. Nat. Hist.*, 1, No. 6, 8, 1883.
[472] Forbes, *ibid.*, No. 3, 148-161, 1903.
[473] Judd, *U. S. Biol. Surv., Bull.* 17, 109-110, 1902.
[474] Beal, *U. S. Biol. Surv., Bull.* 30, 97-100, 1907.
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